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EDITORIALS

NATIONAL COMMITTEES . . .

ELSEWHERE in this number may be found the national committees of the Association for the year 1935-1936. Shaped by the president of the society, G. R. Carroll, and the board of directors, with the purpose of including on each committee, men who are recognized as authorities on particular steel mill subjects, it is important for each committeeman to recognize his duty in seeing that nothing is left undone to make sure that his committee functions in a manner necessary to produce much constructive work for the society and the industry.

These national committees represent the machinery by which many problems of the industry can be solved. Proper guidance of each group, as well as a sincere interest by the members, will enable the society to present the steel industry with the results of studies of every engineering and executive problem.

SPRING ENGINEERING CONFERENCE . . .

NOW AN ANNUAL EVENT of the society, the Spring Engineering Conference, sponsored by the Combustion Engineering Division of the association, will be held in Youngstown, Ohio, April 22 and 23, 1936.

Under the guidance of the Combustion Division, this yearly meeting has grown to be one of the most important functions of the society. Along with the many high caliber technical papers that will be presented at this session, it is also planned to have an inspection trip to one of the modern hot and cold strip mills just completed in the Youngstown district.

Among the subjects to be discussed at the conference will be cleaning of blast furnace gas, refractories, and other related subjects.

CONVENTION AND EXPOSITION . .

THOUGH TEN MONTHS AWAY the annual convention and iron and steel exposition to be held in Detroit next year, September 22, 23, 24, 25, is rapidly shaping up to promise the largest ever held by the society.

The iron and steel exposition, to be conducted concurrently with the convention, is attracting more attention than any ever held by the association. At this particular time with the floor plans out just a month 80% of the space is reserved. When it is taken into consideration that the amount of space available will be twice that had in Pittsburgh this year, it speaks well for the confidence built up in this show as the logical place for displaying the equipment necessary for the production and processing of steel.

Many steel producing companies also have signified their intention of utilizing the exposition to show industrial Detroit the many varied steel products consumed by that district.

CONTROLLED ATMOSPHERE

APPLICATIONS TO HEATING OF STEEL

By T. B. BECHTEL, Engineer
Electric Furnace Company
SALEM, OHIO

Paper presented before the A. I. & S. E. E. Convention, Pittsburgh, Pa., September 24, 25, 26, 1935

▲ OXIDE FORMATION on steel raised to elevated temperatures is governed, for the most part, by time, temperature and atmosphere.

Time and temperature are usually fixed by the requirements of the heating operation, so that atmosphere is the only remaining variable or factor with which to work in the elimination or control of scale formation.

T. B. BECHTEL

REQUIREMENTS AND APPLICATION OF THE CONTROLLED ATMOSPHERE GASES

The use of controlled atmospheres in heating operations on metal products is, of course, not new. Typical examples which may be cited are the use of natural gas, and in some cases producer gas (either of which may or may not have been slightly modified) in the box annealing of steel sheet or strip; of hydrogen or nitrogen in certain cases; and of steam in the annealing of copper. These gases all have certain inherent drawbacks, such as the expense of either hydrogen or nitrogen, the problem of "sooting" resulting from the use of uncracked natural gas, the wetness of product protected from oxidation by a steam atmosphere, etc.

As concerns the use of the modern type of controlled atmosphere, however, the application is comparatively new, a development of the past 3 or 4 years, at the most, in actual commercial usage. The major requirements of this type of controlled atmosphere may be generally visualized as contrasted to the objections set forth above to the use of gases mentioned as typical of older practice. This new form of controlled atmosphere is the product of partial combustion of suitable gases usually containing considerable portions of hydrocarbons or of hydrogen plus hydro-carbons, with a deficiency of air as compared to that required for complete combustion.

The produced controlled atmosphere gas may be easily varied over a comparatively wide range, but for practical applications the analysis, as concerns the important reducing constituents will usually be within the following limits:

H_2—2 to 18%
CO—3 to 11%

It is important, for universal application, that the basic materials required in the production of the controlled atmosphere be readily available. Since city gas, and natural gas from private or public service companies' mains, and liquified hydrocarbon gases such as Butane, Propane, etc. have all been used successfully as bases for the production of the types of controlled atmospheres under discussion, it may be seen that the problem of availability is solved for the major portion of American industry.

As regards expense, it must be brought to mind that cost of usage is determined not only by the cost of producing the controlled atmosphere, but by its application to the furnace as well. Therefore, type and construction of furnace equipment are important considerations in the usage cost of controlled atmosphere gases. These matters, however, will be discussed later. For the present we may indicate the relatively low cost of the gas itself as being within the limits of 5¢ and 20¢ per M cu. ft. These costs are based upon supply or base gas costs of 40¢ per M cu. ft. with natural gas, and of 70¢ per M cu. ft. with city gas, and are dependent upon the percentage of air used. These figures would be sufficient to include the auxiliary costs of electricity and water, in most cases, but not of maintenance charges, which are negligible, nor of fixed charges which are also low, due to the comparatively modest investment required for the cracking unit.

Some mention may also be made of controlled atmos-

Two pusher type furnaces brazing miscellaneous automotive and refrigerator parts. The assemblies are automatically pushed through these furnaces and discharged securely brazed, clean and bright.

pheres produced by the cracking of natural or artificial gas in the presence of steam, and by the disassociation of amonia. These, however, do not now hold an important place in the picture, due to several reasons, among which are relative complexity of the apparatus required or high cost of the resultant product.

CONTROLLED ATMOSPHERE APPLICATIONS

The major benefits of controlled atmosphere will appear in those operations in which both heating and cooling are carried on within the furnace, or in auxiliary equipment closely linked thereto, as contrasted to hot rolling or forging operations. The reasons may be readily seen and need not be detailed.

Hence, the economic use for controlled atmosphere will be found to lie largely in the fabricating and finishing fields; more particularly on cold finished parts but also with some important applications to hot worked products. There are now many applications of controlled atmosphere in successful operation in these fields. Therefore, it has been considered that the description of a few of these applications would serve a useful purpose at this time.

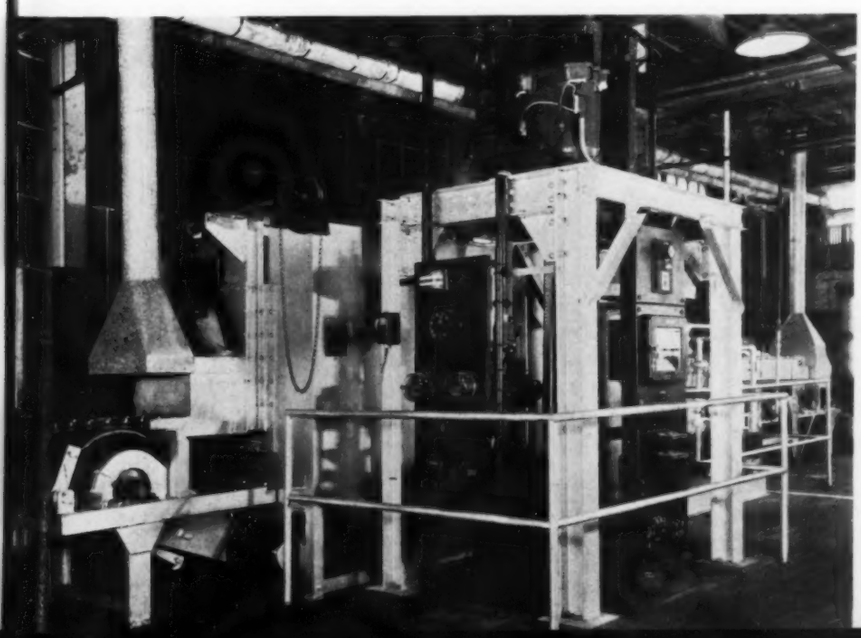
CONTINUOUS BRAZING

One of the most widely used applications of controlled atmospheres concerns the joining of steel parts, such as assemblies of stamped pieces; or machined parts with stampings; or of machined assemblies, in continuous production. Briefly described, the method is to apply a non-ferrous brazing medium in one of several forms to the assembly of parts, and pass the assemblies continuously through a heating furnace at temperature high enough to melt the brazing medium. Controlled atmosphere is employed to prevent oxidation both of molten brazing medium and of steel surfaces. Cooling to practically room temperature is also carried out, usually in a forced cooling extension attached to the heating chamber. The cooling chamber also contains the protective gas atmosphere since it is usually desirable to deliver the brazed assemblies with clean and bright surface conditions. The result is a very strong joint, and at the same time production costs are in most cases sharply cut.

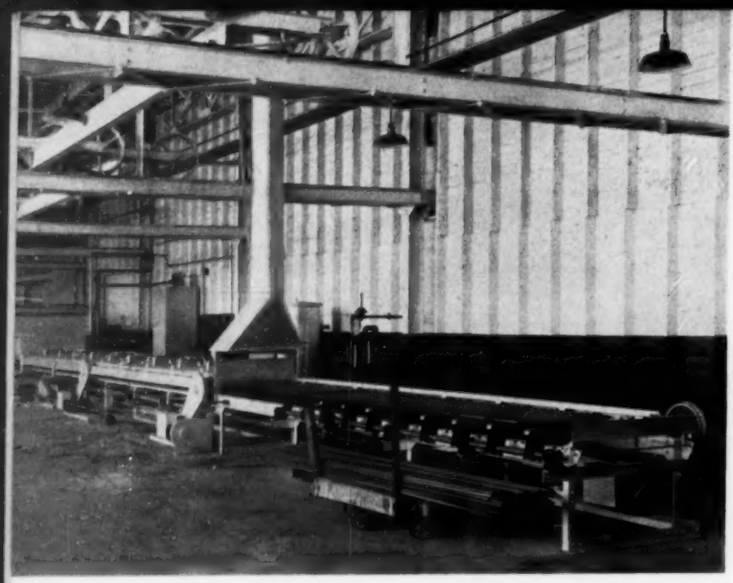
Such furnaces have come into extensive application in the production of refrigerator parts, in a wide variety of parts entering into automotive construction, and in various branches of the steel stamping industry. Novel applications are in the production of watches, of other jewelry, and of the new type of radio tubes where steel shells or bulbs are used in place of glass. Continuous, controlled atmosphere brazing is bound to come into much more extensive use as mechanical designers in general become familiar with its advantages.

ANNEALING OF COLD DRAWN AND STAMPED PRODUCTS

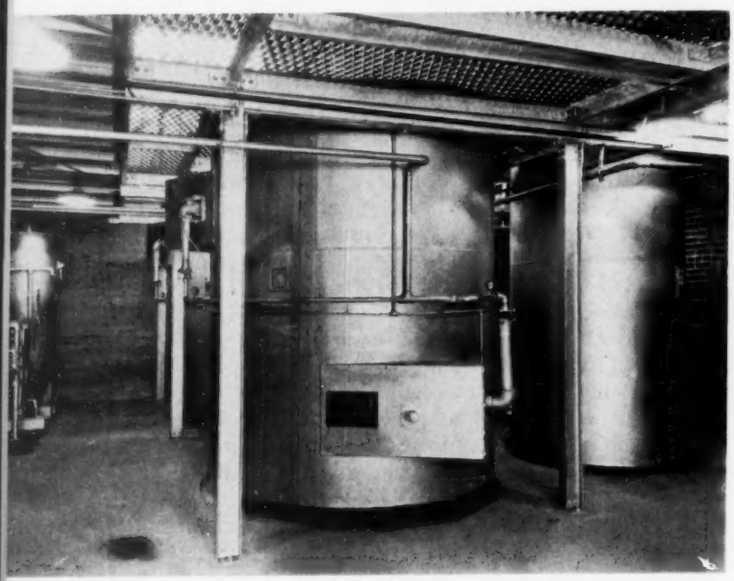
It is quite evident that it is desirable, when products are cold drawn, to preserve the surface conditions re-



Fan pulleys and miscellaneous other automotive and refrigerator parts are brazed in this continuous, conveyor type furnace.



Cold drawn, seamless steel tubing in various diameters and lengths is bright annealed continuously in this controlled atmosphere conveyor type furnace.



Two pit type furnaces for bright annealing wire. The Elfurno gas generator at left provides the special atmosphere used in this equipment.

A continuous, controlled atmosphere furnace for bright annealing fine copper wire on spools—no vapor or water seal is used—the wire comes out uniformly annealed, bright and dry, ready for shipment.

sultant from cold working. Work hardness, however, must be relieved, in a considerable portion of the cold worked products, either for further processing, or to put the metal in condition for final fabrication, and for this, annealing operations are required. Hence, the use of controlled atmosphere annealing equipment here may serve a very useful purpose.

Typical products produced by cold drawing are wire and seamless tubing.

Stampings may also come into somewhat the same classification, both due to the great care taken in the preparation and preservation of surface condition of the sheet or strip from which the stampings are made, and in the method of cold working. Here again a certain portion of the product, i.e., the more difficult parts must be annealed between draws.

Controlled atmosphere equipment for the above is usually of the continuous type as applied to cold drawn tubing and to stampings and, therefore, are ordinarily electrically heated. Wire annealing equipment is usually of the batch type, and since a retort or pot is necessary to the operation as a whole, it depends on the economics of the case as to whether the furnace equipment should be fuel-fired or electrically heated. Non-ferrous wire, however, is being bright annealed in continuous furnace equipments, and, of course, this is possible in the case of steel wire also, depending upon the requirements of the operation.

While discussing the heating of these several products in controlled atmospheres, it may be well to point out the effect of die and press lubricants upon the final surface conditions of the annealed products. If these lubricants are heavy and contain a considerable portion of solids, they will not be removed in the anneal so that the resultant surface will be better described as "semi-bright" or "clean", rather than "bright". In the case of stampings, some jobs may require a wash prior to annealing to deliver the desired degree to brightness as annealed.

Another point that may be brought up here in connection with stampings, particularly concerns the *non-desirability* of controlled atmosphere annealing rather than its use. In certain products which must finally be pickled in any event, process anneals in controlled atmosphere are neither necessary nor of value. In this case, atmosphere control, as contrasted to controlled atmosphere, and as may be achieved in well designed fuel furnaces, will produce an annealed surface, which, though somewhat oxidized, will have no evidence of loose scale which would be detrimental to die life, and which therefore, fulfills the requirements of the case.

SCALE-FREE OR BRIGHT HARDENING

In the case of many small parts, such as bolts, pins, bushings, forgings, etc., which are heat treated in the final machined state, it is again quite apparent that heat treatment in controlled atmosphere will serve a useful purpose. The elimination of scale, preservation of dimensions, elimination of the necessity for a cleaning operation, and better appearance of product result from controlled atmosphere heating.

Problems arise in this connection concerning the requirements of the quenching operation, and the nature

of the quenching medium, generally either water or oil. With suitable care in furnace design or in the arrangement of handling equipment, however, these problems are being met with a high degree of satisfaction. In oil quenched parts, especially those of appreciable size, the surface may be blackened by the quenching oil in contact with the hot metal, but this is not all at detrimental to the product, either as concerns usefullness or appearance, and in some cases may be of value, as it serves somewhat as a rust preventative, if the parts must be stored for a considerable period.

CONTROLLED ATMOSPHERE ANNEALING OF HOT ROLLED PRODUCTS

Hot worked products are of course not susceptible to "bright" annealing in the ordinary sense of the word. If the scale, however, is in the proper condition, as for example in certain classes of hot rolled sheet, it appears that a continuous anneal in the presence of a controlled reducing atmosphere will deoxidize the surface oxide, with a tightly adherent resultant surface. Such surface appears, experimentally, to be very suitable to subsequent coatings.

In the heat treating of hot rolled rod, for cold heading purposes, the material is annealed in the condition in which it is received from the hot mills and later cleaned and drawn to size. Under these circumstances it is, of course, not possible to bright anneal, and neither is it desirable to deoxidize the mill scale, since this would make the cleaning more difficult. It has, however, been found of value to provide a controlled atmosphere of such proportions that the rod surface is maintained in substantially the same condition as received from the mill, with the exception that it has been somewhat loosened by the effect of the heat treatment. By this means the time for pickling has been substantially reduced, and the elimination of pitting has, of course, been found to be beneficial to the surface condition of the rod, and the resultant wire.

BRIGHT ANNEALING OF COLD ROLLED STRIP

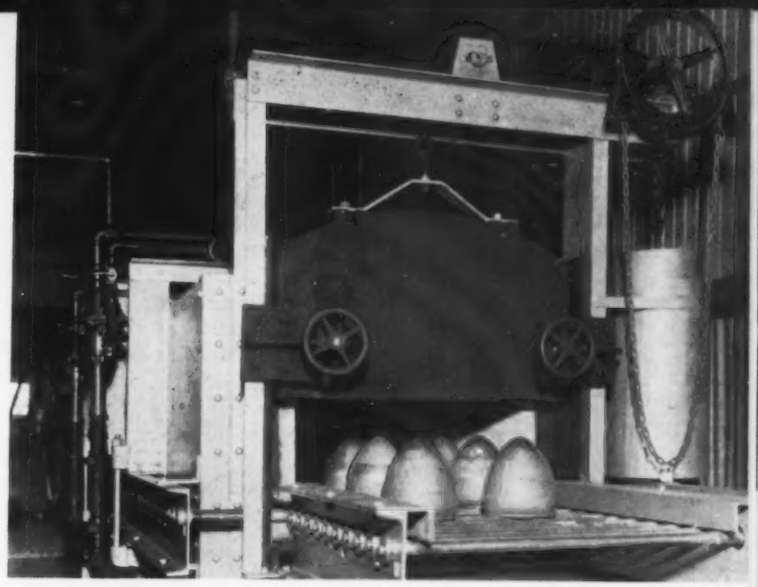
This is one of the most important products for which the application of controlled atmosphere may be useful. However, much has been said and printed in the meetings of this Association and in the technical press in general regarding this operation, both continuously and in batch, and it is unnecessary to go into the matter further, at this time.

EQUIPMENT NECESSARY FOR THE PRODUCTION OF CONTROLLED ATMOSPHERE

As concerns the equipment necessary for producing the atmosphere described above, it may be noted that the requirements are such that the apparatus should be capable of operation with a minimum of care and attention, once it has been started up. It may be desirable, in certain instances to be able to vary the analysis of the produced gas, as applied to a particular furnace or operation, although this is generally not the case. It may also be desirable in periods of low production, or intermittent operation, to be able to shut down and start up the equipment easily and quickly. The units should also be so arranged that the component parts be readily available for the ordinary maintenance operations such as oiling or greasing, cleaning, inspection, etc., and provided with sufficient gauges and other indicators so that operating conditions may be readily checked.

As may be imagined, load conditions attendant upon the operation of these generators are, in the main, fairly constant, particularly in connection with continuous furnaces, but provision should also be made to maintain constant pressure conditions; in the controlled atmosphere unit, over the entire output range.

As developed for the above requirements, the equipment for the generation of the controlled atmosphere gas is relatively simple in design, and very reliable in operation, in addition to which its first cost is quite moderate.

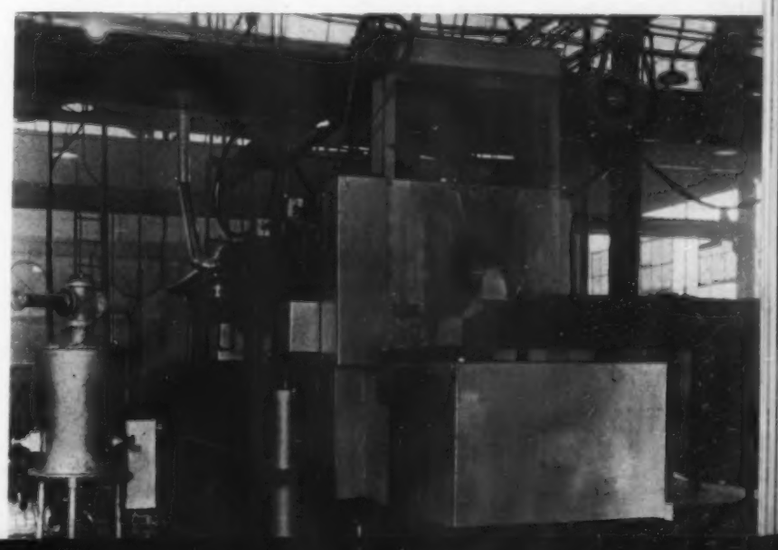


Ferrous and non-ferrous stampings of various shapes and sizes are clean and bright annealed uniformly, economically and with minimum labor in continuous type furnaces similar to the above—no trays are used—100 per cent net material.

FURNACE EQUIPMENT

As concerns the furnace equipment the major requirements are that neither infiltrating air nor products of combustion be permitted to contact the metal being

A special atmosphere, continuous, chain belt conveyor type furnace for scale free heat treating and clean and bright hardening.



heated, and that the equipment be arranged for minimum usage of the controlled atmosphere gas.

The electric resistance furnace is inherently most suitable for the use of controlled atmosphere, for several reasons among the most important of which are: First,—That means to insure gas tightness may be confined to the outer shell, or binding of the furnace, which is, of course, not subjected to the effects of high temperatures, and tightness is, therefore, more easily accomplished and more reliably maintained; second,—that direct, or unmuffled heat application inherent in the electric furnace, is the best condition for uniformity both throughout the heating chamber and with reference to temperature gradient between heat source and receiving bodies.

Direct firing of fuel-fired furnaces will not satisfy the requirements of those applications in which the use of controlled atmosphere is indicated, one of the main reasons being that both water vapor and carbon dioxide are oxidizing agents, when in contact with heated steel surfaces, and both are combustion products in normal furnace operation. Other considerations such as those concerning the necessity of openings in the furnace for vent ports, and their effect upon air infiltration control, etc., are also factors. Therefore, the fuel furnace, as used in controlled atmosphere work must have an intervening barrier, such as a retort, a muffle, or a multiplicity of combustion tubes interposed between heat source and work.

In batch furnace applications, the requirements of the operation are such as to necessitate the separation of furnace from charge at some point in the cycle, and removing the charge from the protection of the furnace. In such applications, the use of a retort offers a convenient and perhaps the most reasonable solution. The major problem then becomes the matter of gas tightness in the retort proper.

In continuous furnaces, except in smaller sized units, retort design and maintenance present serious problems. Combustion tubes in such applications are comparatively new and untried and possible problems that may develop if their use is continued concern temperature distribution, disposal of products of combustion, maintenance cost, except in low temperature operation; the matter of furnace tightness about the multiplicity of expanding and contracting openings into the furnace structure, and possible disturbance of furnace atmosphere in the event of tube failure. It would appear that for continuous furnace applications necessitating controlled atmosphere, and where economic conditions are not too favorable, the electric furnace offers less compromise than any other.

Other than as noted above, the furnace requirements for controlled atmosphere applications are quite conventional, with perhaps the single exception of furnace lining. Conventional types of conveying mechanisms are employed, the greatest change from ordinary design and appearance being evidenced in the necessary means to insure gas tightness.

A special atmosphere furnace for bright annealing cold rolled steel strip continuously. The material is delivered to the furnace in coils, uncoiled at the charging end and conveyed at a relatively high rate of speed through the heating and cooling chambers in a special atmosphere and recoiled at the discharge end.

Pit type furnace installation for clean normalizing, spheroidizing and bright annealing steel wire and rod in coils.

COMPOSITION BEARINGS

FOR ROLL NECKS AND OTHER PURPOSES

By H. M. RICHARDSON
Plastics Department
GENERAL ELECTRIC CO.

Paper presented before the A. I. & S. E. E. Convention, Pittsburgh, Pa., September 24, 25, 26, 1935

▲ IT HAS BEEN clearly demonstrated over the past six or seven years that water lubricated nonmetallic bearings can be successfully applied to heavy duty rolling mill equipment. They have been used on almost all types of rolling mills with the exception of the ordinary 2-high hot sheet mill, which is not water cooled and on which the normal neck temperature is above the charring point of nonmetallic bearings.

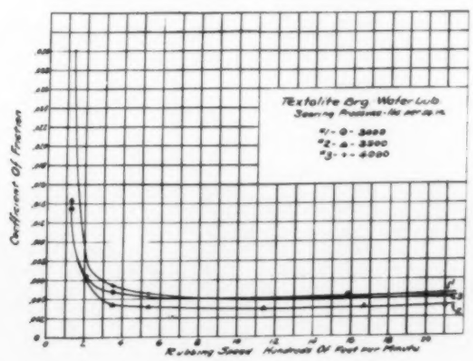
Let us examine some of the problems connected with the application and use of composition bearings; obstacles which can be eliminated in order to gain the fullest benefit from the use of the bearings.

One problem has been that of the amount, the purity and temperature of the cooling and lubricating water. It is well known that in some mills where the water temperature in the summer time is much higher than in the winter, the life of the bearing is shorter during the hot weather. We ran a series of tests to find the friction characteristics of Textolite bearings at various loads and speeds as a function of the temperature of cooling water.

In the first place, let us get in mind what the coefficient of friction of composition bearings should be under ideal conditions. Figure 1 shows the friction characteristics of a Textolite bearing at pressures from 3000 to 4000 lbs. per sq. in. and speeds from 125 to 2100 ft. per min. You will note that the curves are practically flat from about 400 ft. per min. on out with a coefficient of friction of .003 to .005. Lubrication was with clean, fresh water at about 25 to 30° C. It

H. M. RICHARDSON

Fig. 1



is hardly conceivable that such low coefficients of friction would be obtained unless the journal were riding on an actual water film. If this is true, and we are able to maintain a water film, then we should find lower coefficient of friction at the higher temperatures because of the decrease in the viscosity of water. (See Figure 2.) Here, we have the viscosity of water as a function of temperature and see that its value is cut in two by raising the temperature from 20° C. to 50° C. Therefore, if in practice we actually get higher friction, there must be some breakdown of the water film—allowing hot spots to develop in the bearing—accompanied by increased rate of wear. Obviously a large flow of water—even at high temperatures—will help to eliminate the hot spots—so for the purposes of the tests we used a very large flow of water—about .65

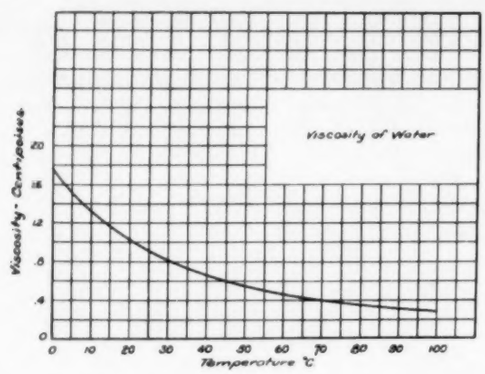


Fig. 2

gallons per minute per square inch of bearing area—and applied it by means of slotted spray pipes like the one in Figure 3, so the cooling water covered all parts of the exposed journal surface. There was sufficient flow of water that a larger amount would have made no appreciable difference in the test—since we were trying to find the effect of temperature of the water, rather than the amount. The journal was driven by a cradle type dynamometer operating as a separately excited D. C. motor with Ward-Leonard speed control. The torque reaction was measured by the dynamometer beam scale and a recording ammeter was placed in the armature circuit to record the fluctuations of current which is proportional to torque and can be calibrated in ft. pounds by referring to the corresponding beam scale readings. The tests were started with water at about 25° C. Water temperature was increased in steps of 5° C. at 10-minute intervals. The results will be seen in Figures 4-5-6-7. Figure 4 shows performance at 2000 lbs./in.^{2} and rubbing speed of 1000 f.p.m. Here, you will notice that operation was quite stable up to 66° C. (151° F.)—at this point the water film broke down—a hot spot developed which caused the bearing to seize and stop the test. At the beginning of this test the surface of the journal was of a dark color with a high polish which was left from the previous run on another set of bearings. The finish stayed on the shaft until the water film broke down—when it was rubbed off and the shaft was smooth and bright. Figure 5 shows the same conditions of load and speed, but with a different set of bearings having an improved and somewhat harder and more stable structure which we have recently adopted. Here you will note that operation was stable clear up to 86° C. (187° F.). When we tried to raise the temperature to 91° C. the water film broke down and the bearing surface was burned.

Figure 6 shows performance of bearings made just like the previous set, but operating at 2000 lbs./in.^{2} and 600 ft. per min. Here we had fairly stable operation up to 84° C.—In this case our water supply failed by jamming of the pump—so the test stopped.

Figure 7 shows the same type of bearing operating at 3000 lbs./in.^{2} and 600 ft./ min. Here the temperature was run up to 74° C. and then lowered to see if the bearing would recover its low friction. When the test started the friction coefficient was about .003, which rose to a maximum of about .012 and then decreased to about .005—After concluding this test these bearings were run for an hour at 2000 lbs./in.^{2} and reached a coefficient of .002.

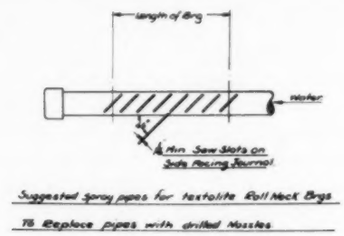


Fig. 3

From these tests it is evident that by supplying plenty of water to composition bearings, it should be possible to operate them successfully where water temperatures do not exceed, say, 45° C. (113° F.), which is about as high a water temperature as I have heard of for use in a mill—These bearings should be made with a resinous binder which is very hard and very thoroughly cured in order to avoid unstable operation and "hot spots".

Smoothness of neck surface becomes more important as the temperature of the cooling water rises. We have found that journals operating for a period of several hours under heavy loads, but low friction, often develop a very dark colored surface with a high polish. The color ranges from a straw to a blue or purple similar to the colors which appear on tool steel when it is heated for drawing the temper. A high coefficient of friction will rub off this color and leave a bright surface.

Preliminary tests indicate that a small amount of grease injected into the bearing at infrequent intervals

Fig. 4

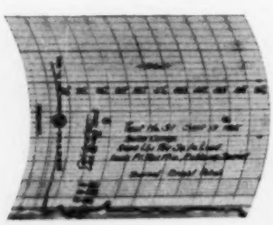
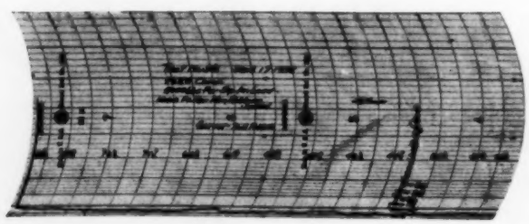


Fig. 5



tends to stabilize the friction coefficient. This grease seems to imbed itself into the surface pores of the bearing and act as a secondary defense against hot spots when the water film fails momentarily.

This has been verified by the reports of operating men in different parts of the country.

The practice of swabbing the roll necks with grease when the mill stand is set up, or when the mill is shut down, is also beneficial in this same way.

The purity of the cooling water is also an important factor. Acids or salts in the cooling water will often corrode the surface of the roll neck and prevent the maintenance of a smooth journal surface. This results in shorter bearing life. This effect is much more pronounced as the temperature of the cooling water rises above, say, 90° F.

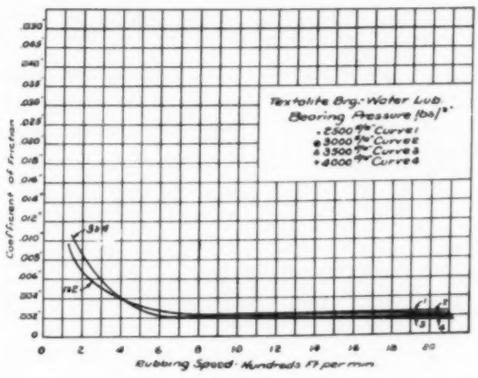

Textolite Brg. Water Lub
Bearing Pressure lbs/in²
2500 ft Curve 1
3000 ft Curve 2
3500 ft Curve 3
4000 ft Curve 4
Coefficient of Friction
Rubbing Speed - Hundreds ft per min

Fig. 8

Some work has been done with emulsions for lubricating composition bearings. We have found that emulsion of mineral oil—about 2½% in water—has all the advantages of water lubrication and is, apparently, somewhat more stable at low speeds. It has the advantage that it automatically provides a protective oil film on the journal when the machine is shut down. The most promising potential applications for emulsion-lubricated composition bearings are in cold rolling mills, or on machine tools where the emulsion can also be used as a coolant for the work. Figures 8 and 9 show two tests on the same bearing—one with water lubrication and one with emulsion lubrication.

The amount of water necessary for cooling is dependent on several factors. First is the amount of heat generated in the bearing. The rate of generation of

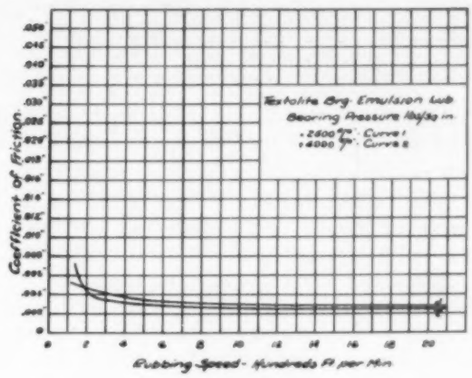

Textolite Brg. Emulsion Lub
Bearing Pressure lbs/in²
2500 ft Curve 1
4000 ft Curve 2
Coefficient of Friction
Rubbing Speed - Hundreds ft per Min

Fig. 9

heat at any instant is $\frac{f \times p \times S}{778}$ b.t.u. per sq. in. of bearing area per min., where "f" is the coefficient of friction, "p" the pressure in lbs. per sq. in. and "S" the rubbing speed in f.p.m. In other words, the heat generated goes up directly as the friction coefficient, the pressure, and the speed.

Second is the duty cycle—whether the pressure and speed are intermittent with periods of light load in between.

Third is the amount of heat transmitted to the roll neck from the roll body or the couplings.

Fourth is the efficiency with which the water carries away the heat from the neck surface.

In order to get the best efficiency out of the cooling water, the spray pipes should be designed to bring as much of the cooling water in intimate contact with the neck surface as possible. This means that the jets of water must be as many as practical and that they must impinge on all of the available open neck surface.

There is another type of mill which requires four spray pipes per neck to give necessary cooling effect. Two or three rows of holes in the spray pipes which direct the water on a large area of neck surface are much better than a single row of holes directing the same amount of water on a smaller area.

This thought also brings up an important point in the design of the bearings. We see from the standpoint of cooling that as much of the neck surface as possible should be available, and we have found by experience that with Textolite bearings (with their lower coefficient of friction) the arc of contact can be much less than with metallic bearings to maintain proper roll align-

Fig. 6

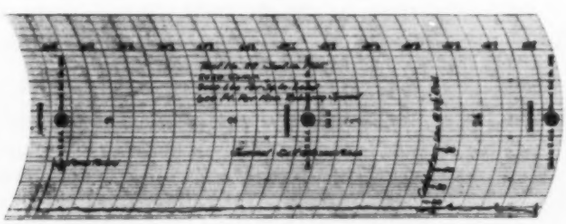
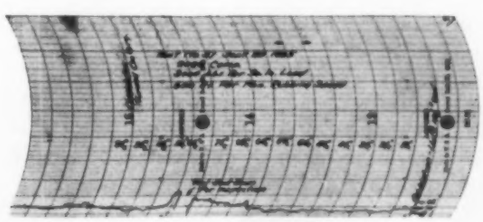


Fig. 7



ment. For roll necks without side bearings, this arc of contact can range from a minimum of 90° to a maximum of about 135°. Single stands not reversing, or stands in Belgian type mill, will use 90° to 120°, while stands in continuous mills or reversing mills will use bearings from 120° to 135°. On large mills with side bearings the top and bottom bearings should range between 60° and 90°.

On mills rolling shapes or rounds where it is the usual practice to hold a very tight mill, there is a tendency to rapid wearing out of thrust collars until the roller learns the "feel" of the nonmetallic bearings. The reason for this is that the resilient, nonmetallic thrust collars will compress about 20 times as much as under a tight end adjustment as a corresponding bronze or babbitt collar. This means that a much greater wear occurs in the nonmetallic thrust collar than in the metal thrust collar before it clears itself enough to allow the lubricant to enter. This situation can be helped considerably by designing the thrust collars to give as large an arc of contact as can be had. This may be carried to a limit by making a chuck that provides a full ring thrust collar—as has been done in some cases with considerable success. The best results can not be obtained, however, until the roller operating the mill learns the "feel" of the bearings so he can hold the mill tight enough to hold section, but not so tight that the thrust collar is worn out too rapidly. It has been found by experience that often the first collars are short lived but that each succeeding set lasts longer until the life of the collars is comparable with that of the radial linings.

Another factor affecting the life of the thrust collars is the amount of backlash in the mill. It is true that a mill with properly adjusted nonmetallic bearings runs very free, so a rattle often develops in the couplings. This rattle is some times taken out by tightening the thrusts, which shortens their life. If this rattle can not be removed by improving the roll alignment, or by dressing up the couplings, it may be necessary to put a drag or brake on the roll neck. This brake can be in the nature of a rider bearing for the bottom roll and loaded by spring pressure; or on some mills, by mounting a brake outside the housing and coupled to the outer ends of the rolls. If the need for this brake can be avoided by improving the couplings, it may be worth while, because any such friction drag costs money to operate, since it uses up some of the power saved by the low bearing friction.

Another problem in the design of nonmetallic bearings is to choose the proper thickness of lining. As a rule, the thickness of lining and thrust collar is determined by the amount of material which must be machined out of the old bearing or chuck to give the nonmetallic material a good backing. This procedure is usually all right because the resulting lining thickness is not enough to add an objectionable amount of "spring" to the mill—except in the case of mills rolling thin strip or sheet. This is particularly true in the case of hot strip mills. The strip is held to close tolerances, and the usual practice seems to be to hold the thickness a little toward the high side of the limit. Thus, if there is too much "spring" in the mill, the temperature variations in the strip may allow the cooler parts of it to go outside the tolerance limits. The "spring" in the Textolite bearings can be kept in mind as .002″ per thousand pounds per sq. in. bearing pressure per inch of bearing thickness. Experience has shown that $\frac{5}{8}$″ is the maximum lining thickness for radial bearings on hot strip mills.

Another factor which has been noticed from time to time is a certain amount of scoring on the necks of alloy steel rolls—operating on fabric base composition bearings. This, we believe, is caused principally by the surface of the bearing becoming charged with abrasive material such as scale, red oxide or sand. It can be minimized by providing good scale guards over the roll necks on the stands where there is a lot of flying scale, and by keeping sand or other abrasives out of the water supply. Such scoring seldom occurs on the necks of chilled iron rolls, which are quite hard, and on relatively few steel necks. Where it has occurred, the necks have a hardness of 35 scleroscope—or less. Tests are being run now to find the minimum hardness, above which such scoring is not likely to occur.

Other applications for composition bearings—aside from roll neck bearings—have been tried and found successful. These applications fall into four classes:—

1. Water lubricated bearings—on table rolls, centrifugal pumps, etc. These applications follow the same rules to give success as for roll neck bearings—plenty of clean water, adequate provision for circulation of water, means for preventing corrosion during shutdown, and journal surfaces of reasonable hardness.
2. Grease lubricated bearings which are used intermittently and are not often lubricated. An example is the bearings of the line shaft on a crane in a sheet mill. Grease must be used sparingly so no drip will fall on the finished sheets. The service is intermittent, so the heat of friction can be easily carried off through the shaft. The scanty grease lubrication does no particular harm, since the bearing will not seize and injure the shaft. In one case the bearing was greased when installed and then run without further attention for a whole year. The wear in this time was about $\frac{1}{32}$″.
3. Bearings subjected to heavy impact loads in intermittent service. These are grease or oil lubricated and have an overall load—speed duty cycle which allows the heat of friction to be carried off by the journal. The advantage of composition bearings in such locations is that they don't pound out like babbitt bearings, nor crystallize and cause scoring like bronze bearings. In one of our own plants we have these bearings installed on the shaker arm of a sand slinger in the foundry. It has outlasted the previous bronze bearing by about 2 to 1.
4. Oil lubricated bearings with circulating oil lubrication in which the heat of friction can be carried away from the bearing by the oil and by the journal. Here the composition bearing has no advantage over good babbitt bearings except where occasional heavy loads or impacts are encountered.

COMPOSITION BEARINGS

RECENT PROGRESS IN THEIR USE

By K. T. MacGILL
Manager Ryertex Division
JOSEPH T. RYERSON & SON, INC.

Paper presented before the A. I. & S. E. E. Convention, Pittsburgh, Pa., September, 24, 25, 26, 1935

▲ IN NOVEMBER of 1932, I had the privilege of talking to this group on the subject of composition bearings under the heading of "Reducing the Bearing Cost Per Ton of Steel Rolled". At that time, the thought of using a laminated synthetic resinous type of bearing for roll necks was a new idea to most of the men present.

Today, I would venture to say that there is not an engineer or operating man here who has not had actual experience with composition bearings and who has not personally seen in actual practice the advantages which can be derived from their use.

In '32, composition bearings were used mainly in the smaller high speed mills. Now the composition type of bearing is in use in practically every type of rolling mill with the exception of hot sheet mills where the temperatures on the barrel of the roll are from 700 to 800 degrees Fahrenheit, which is too hot to permit satisfactory bearing operation, with water for a lubricant.

It was thought in the beginning that water lubricated bearings would not function on slow speed roll necks; now; installations are common in such applications as reversing blooming mills and No. 1 roughing stands in continuous mills where the speeds may be considerably under 100 surface feet per minute on the surface of the roll necks.

In '32, it was a mooted question as to whether the water served only as a coolant or formed a film as an actual lubricant.

Experiments with dry ice as a coolant, perforated bearings with the holes from the bearing surfaces connected to long glass tubes and also composition shafts running inside of glass bearings have shown visibly and beyond further argument that a lubricating film is formed and maintained under varying speeds and pressures, when water is properly applied.

The question of permissible bearing pressures is being answered by actual installations. Bearings are in service which are working under a loading, estimated to be as high as 10,000 lbs. per sq. inch. This application, however, is not a rolling mill. We do know of rolling mills where pressures are as high as 7500 lbs.

Maximum rolling mill pressures are probably reached in the large backing up rolls on 4-high mills, but these pressures are well within the safe load carrying range of the laminated synthetic resinous type of bearings, and such installations in both continuous and reversing types of mills are proving their ability, after six months

K. T. MacGILL

service, to work satisfactorily under these conditions without any appreciable change in motor load or depreciation of quality of material rolled, and, at a very moderate first cost.

The advantages of the use of composition bearings in four high mills are many—perhaps one of the most important, the diameter of the roll neck can be increased 25% or more, thus reducing unit bearing pressures, increasing bearing life and providing a more rigid roll and increased roll life. Under proper operating conditions, the roll neck temperature remains constant at about room temperature which makes for rolling to closer tolerances and fewer mill adjustments.

The range of application for composition bearings covers practically every mill bearing where water can be used for a lubricant. At this time, we might say, almost regardless of speeds or pressures. The benefits

from the use of these bearings in particular as compared to bronze or babbitt bearings, are summed up briefly in—

reduced power consumption
oil saving through water lubrication
ability to roll to closer tolerances
longer bearing life
fewer mill adjustments
safer operating conditions

In the manufacture of the bearings themselves, many changes are taking place, improvements in materials are giving harder bearings with longer life and still lower coefficient of friction. (Definite methods of testing bearings have been developed, so that bearings can be checked to a standard and their uniformity assured.)

The experience gained from you men who operate mills with composition bearings has permitted a definite technique to be developed in the handling of these bearings, and of their design, and the proper method of applying water to lubricate them. Your reports on bearings which have failed have been most enlightening and have shown the way to prevent a recurrence of the trouble.

It really has been surprising the few things which can cause these bearings to give trouble. They can all be classified in two general groups, headed "Water" and "Pressure".

Under "Water" is found—

insufficient quantity — { low pressure / clogged sprays
not properly directed
too hot
carries too much abrasive

The answer to all water problems is found in a realization of the fact that the function of the water is to serve as a lubricating film and to dissipate the heat from the work done in the bearing.

As the temperature of the water rises, its viscosity decreases and it has less strength to serve as a separating medium between the bearing and the journal, as work done in the bearing increases, the heat to be carried away increases. It is obvious therefore that there should be flexibility in the water supply if the proper rate of heat dissipation is to be maintained with varying load conditions.

It is true many mills turn on a supply of water to take care of maximum load conditions but where the supply of water is limited or the cost is high, intelligent supervision and consideration of what the water is supposed to do will save many gallons every minute.

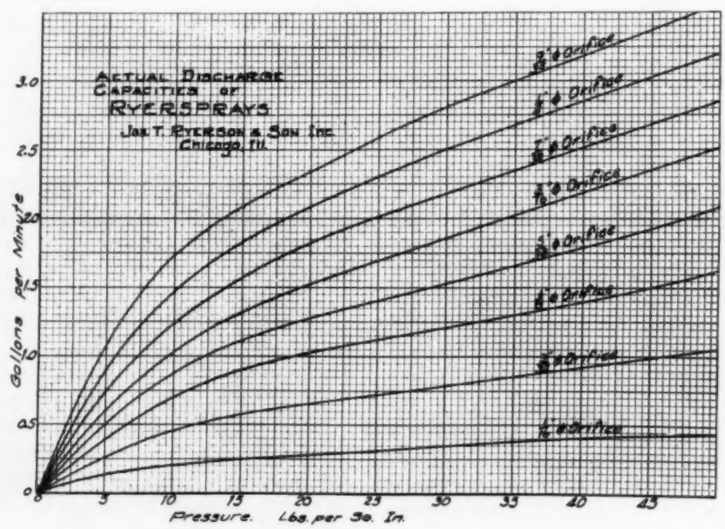
In the Summer, with water temperatures from 20 to 50 degrees warmer than in the Winter, and room temperatures up a corresponding amount, more water will be required than during Winter operation. When it is realized, for example, that water at 50 deg. F. has a density of .42 lbs. per cu. ft. and a viscosity of 1.310 and this changes to a density of .20 and a viscosity of .433, at 150 deg. F., it can be appreciated why there must be flexibility in the water volume in order to maintain even operating conditions. The only water which does the bearing any good is that which strikes the journal at a proper angle; loose water pipes and sprays which can get out of position have been responsible for many a lost bearing and wasted gallon of water.

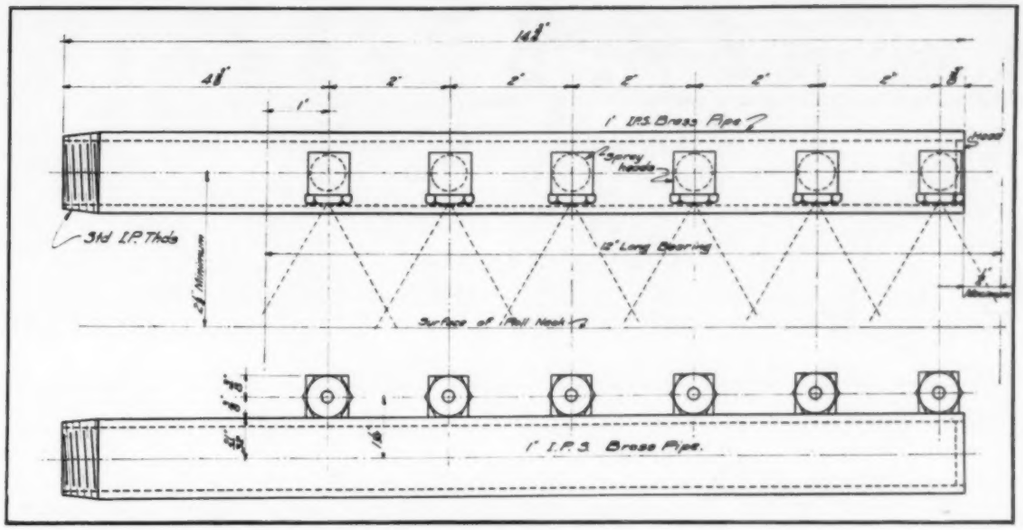
Along the line of more efficient use of water coupled with a reduction in the amount used to get satisfactory operation, we have found that the use of a nozzle throwing a conical shaped spray will better cover the exposed surface of the roll neck. The sketch shows a typical spray pipe and indicates the pattern of the conical spray.

A spray nozzle with an eighth inch hole, for example, will use only half the amount of water that would be ejected from a drilled hole of the same size under the same pressure conditions, and furthermore, because of the better distribution of water by the spray nozzle, only half as many nozzles would be required as drilled holes to get the same cooling effect. The spray pipes are furnished with removable orifices and any orifice from $\frac{1}{16}$" to $\frac{9}{32}$" may be used as required to meet the service conditions. The accompanying chart shows the volume in gallons delivered by the different openings at different pressures.

Under the "Pressure" heading is found—

Bearings not properly lined up, concentrating the entire load on one end or the other, may create such tremendous pressure at the point of contact that the water film cannot take away the heat and breaks down, greatly increasing the pull on the motors, and may even kick out the circuit breakers or if enough of the bearing





Detail for Standard Spray Pipe for 12 inch Long Roll Necks.

is in contact with the roll neck, the wiping action may be so great as to break out the keeper plate bolts and turn the bearing out of the chuck.

If bearings are out of line, even a normal pressure on the end adjusting screws will also localize the entire load on a point on the thrust, and either crack the bearing in the fillet or break out the bottom of the thrust depending on which way the bearing is cocked.

We had an example of this particular trouble brought to our attention recently by one of our Chicago Mills. The Rollers found that the radial shells were not wearing evenly, in some cases, the outside ends were wearing thin and in others, it was the inside end of the bearing which was showing excessive wear. This condition did not show up on all stands but only on the roughing and intermediate stands.

On the roughing stands, the excessive wear was on the outside ends of both bearings. On the intermediate stand, the condition was reversed and the inside ends were wearing thin. An examination of these stands showed that the center line of the vertical screw was not in the center of the bearing.

In each case, the end of the bearing which was showing excessive wear was the end which was closest to the center line of the screw.

This condition could easily come about through the use of a roll that was shorter than standard, requiring the bearings to be pushed farther through the housings in order to make contact with the roll shoulder, and of course, the reverse would be true if a longer roll were used, or if thicker or thinner collars were used on the bearings. There are any number of combinations which occur to contribute to this off-center condition.

It has been standard practice to use a screw with a round end and a cupped breaker block; with this combination, the pressure is applied through the center of the cup, and this center of applied pressure being closer to one end of the bearing than the other, naturally produced excessive wear on the short end.

To correct the trouble, the Superintendent had the ends of the screws squared and used a flat breaker block. After three weeks of operation, with the same rolls, the bearings were checked and found to be wearing evenly, and no further trouble has been experienced.

With the bearing properly lined up, proper end screw adjustment is most important. The tremendous pressures used on bronze bearings applied through a long handled wrench with a pipe on the end of it are unnecessary with this type of bearing. Mills that are getting the most satisfactory service from their composition bearings have persuaded their rollers to throw the pipe away and shorten the wrench handle.

It has been our experience that where the Superintendent or Mill Foreman (who is in possession of these facts) take the personal interest in the actual use of composition bearings, much better results are obtained. Very often, when the roller cannot make or loses his section, he blames the bearings when it may be any one of many things rather than the bearings, such as not enough water, rolls out of alignment, due to chucks being cocked, too loose couplings and spindles, or a bottom roll jumping, or back lash in the mill due to reduced friction load.

Very often, we find rollers taking up on side screws because mill is noisy due to freer running rolls, than, with metallic bearings, thereby defeating the very purpose of fabric bearings. These things are purely mechanical and with proper care and adjustment, can be overcome.

We feel that in the past three years, a very satisfactory progress has been made in extending the use of composition bearings and with improved mill operations and the desire to roll sections to closer tolerances and further reduce operating costs, the use of this type of bearing should be extended very rapidly.

LAMINATED BEARINGS

THEIR USE IN DIFFERENT TYPES OF ROLLING MILLS

By H. F. HORNE
Micarta Products Department
WESTINGHOUSE ELECTRIC & MANUFACTURING CO.

Paper presented before the A. I. & S. E. E. Convention, Pittsburgh, Pa., September 24, 25, 26, 1935

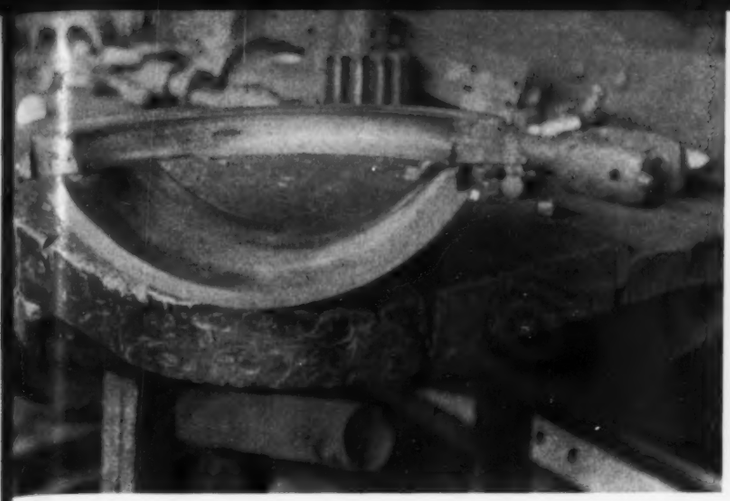
▲ LAMINATED BEARINGS are being universally applied to practically all types of rolling in the iron and steel industry as their remarkable advantages gain recognition among operating men. Frequently, a new product can offer one or two good reasons for its existence, but seldom such pronounced and almost revolutionary advantages as are admitted for non-metallic bearings; power savings ranging from twenty-five to fifty percent, elimination of grease and the cost of applying it, more accurate holding of gauge, reduced number of trial bars when rolls are changed and—as a conservative estimate—twenty to forty times longer life than metallic bearings.

In a general way, these advantages are inherent in the various modifications of laminated bearings as manufactured by Westinghouse and its several competitors, so that in many cases the sole means of judging between them is the length of service an individual bearing will give. This has been improved during the last two years to a remarkable degree. As an example, a skelp mill operating in the Pittsburgh District was quite satisfied with an average life of eighteen thousand tons on laminated bearings. This represented almost eighteen times the life ever obtained with metal bearings, together with very appreciable lowering of operating costs. With the introduction of the latest type Micarta bearing, this life has been raised until from three to four times this tonnage is now consistently obtained. This example is not a freak as other types of mills have shown improvement in approximately the same ratio.

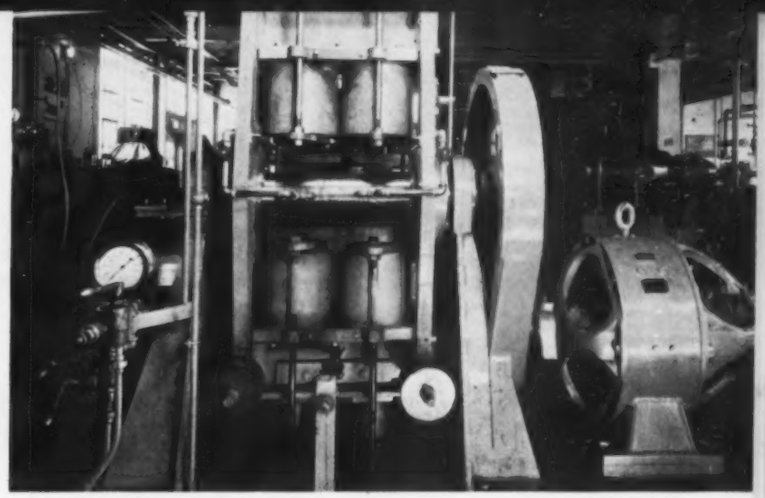
Tracing briefly the various steps in the development of Micarta bearings, many steel men will recall the "on edge" construction of about four years ago. This type was a vast improvement over lignum vitae or metallic bearings and operated entirely satisfactorily for comparatively light pressure rolling such as encountered on rod mills. However, many jobs caused crushing and fracture of the laminations, resulting in rapid failure. The heavy fabric bearing was the next development and represented the first non-metallic bearing which could be practically universally applied. Its chief advantage lay in its ability to stand higher pressures than the "on edge" type. On light pressure work, its life was not materially longer. It represented a major step forward, however, and many bearings of this type are manufactured and used today. In the process of reserch and development, the Westinghouse Company advanced an entirely new basis of bearing manufacture. The process consisted of altering the physical properties of the synthetic resinoid prior to the impregnation process. In order to incorporate as great a percentage of this resin as possible in the bearing, resort was again made to a finer fabric, although with this improvement, the laminations were molded in the conventional direction. The ultimate product was an improvement over any other bearing made in the ratio

H. F. HORNE

Micarta bearings on 16 inch cold strip mill. These bearings are outlasting metallic bearings 54 to 1.



Micarta linings removed for inspection at end of 952 hours of service in 16 inch cold strip mill. This bearing will give at least 800 hours more service.



Machine used in development and testing of micarta bearings.

already alluded to. This type should never be confused with any of the earlier attempts to utilize a fine weave fabric and a standard type of resinoid, as the results on this latter were never satisfactory. The long life of the present Micarta bearing, of course, necessitates less frequent "screw downs" and test bars, and the frictional properties are equal in all respects to any of the heavy fabric type machining.

These bearings are molded in semi-circular molds at extremely high pressure, applied in the same direction as the roll neck pressure. Thrust blocks are machined from plate stock of the required thickness. This allows for replacement of either the radial or thrust portion independently.

Many experiments have been run employing graphite and other so-called self-lubricating agents impregnated in the bearing. In no case, where the recommended lubricating means have been adhered to, have these graphitized bearings shown any frictional advantage. There is, on the contrary, a decided weakening of the laminated structure which results in much more rapid failure.

It may be helpful to enumerate the various types of rolling mills in which our bearings have been successfully applied:

ROD MILLS

This represents a fairly easy application and a number of mills are completely equipped throughout the country. Several others are also partially equipped including three or four roughing stands in addition to the finishing stands. The average tonnage approximates 70,000 tons per bearing compared with 2,000 tons formerly obtained on metal. On the highest speed stands our bearings have frequently rolled over 200,000 tons, and in some instances as high as 450,000 tons, versus 2,000 tons on metal bearings. These figures were obtained on one of our earlier type bearings and since that time other improvements have been made. As a matter of fact, installations employing new bearing materials can not be judged accurately for ultimate life in a period of less than a year. Power savings on this type of installation average over 30% and gauge is materially better due to the much slower rate of wear on the bearings.

MERCHANT MILLS

Several mills of this type have been equipped. These installations are confined to the finishing and leader passes and here these bearings have shown durability and power saving. Thrust is a considerable problem in a mill of this type and the two-piece construction has a decided advantage. In general, 20 times the life of a brass bearing is obtained.

STRIP MILLS

Quite a number of continuous hot narrow strip and band mills are equipped with Micarta and are outwearing an average of ten metal bearings. Still greater life advantages could be shown except that it is necessary to use a thin radial lining averaging ½". This is to insure the bearing against flexing on the high pressure encountered as the modulus of compression on the laminated material is lower than on metal. 30% power savings or better is consistently obtained on this type mill with non-metallic bearings.

BAR AND BILLET MILLS

Laminated bearings have been very successful on bar mills, both sheet bar and those rolling rounds and squares. Power savings of around 35% are shown and a durability of ten times that obtained with metal bearings. In addition, rejections for off-gauge steel have been cut materially since the adoption of these bearings. This saving alone, more than justifies the cost of installation and at least 200,000 tons is the indicated life in this duty with the latest bearing.

BLOOMING MILLS AND HOT SHEET MILLS

Installations of these bearings have been made in mills of both types but only recently so that service records are not complete. From all indications, however, laminated bearings are entirely practical for such duty and show the same general advantages of power saving and long life as in other mills.

Practically every type of iron and steel rolling has thus been successfully accomplished with laminated bearings. A few applications such as cold sheet mills still offer some problems which have not been entirely solved, but development work is being continued on these lines. All of these developments point to worthwhile savings in the cost of mill operations.

OIL FLOODED BEARINGS

USES IN STEEL ROLLING MILLS

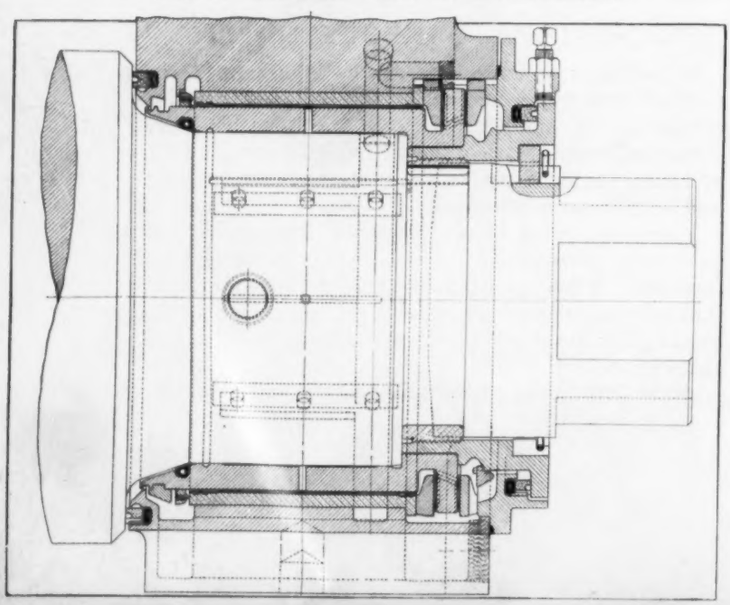
By J. H. HITCHCOCK, Engineer
Morgan Construction Company
WORCESTER, MASSACHUSETTS

Paper presented before the A. I. & S. E. E. Convention, Pittsburgh, Pa., September 24, 25, 26, 1935

▲ SINCE THE INTRODUCTION of Morgoil bearings, rolling mill engineers have shown considerable interest in the theory of perfect oil-film lubrication. For this reason it is probably unnecessary to discuss here the theoretical considerations underlying Morgoil design. However, for the benefit of those who are not yet familiar with the construction of Morgoil bearings, it may be worth while to describe briefly their principal features.

The cross-section of a typical Morgoil bearing is shown in Figure 1. It will be observed that the bearing includes an inner race, or sleeve, which rotates with the roll neck. This sleeve is made of heat-treated forged steel, and serves as the bearing journal. It is constructed with a flange at its outer end which constitutes the rotating member of the thrust bearing. The sleeve itself is carried in a steel bushing lined with centrifugally-cast babbitt, while the thrust flange is placed between two stationary steel thrust rings, having centrifugally-cast babbitt facings. All of these operating parts are enclosed in a cast steel casing which is provided with seals to exclude water and dirt. The bearing assembly is held in place on the roll neck by the conventional method employing a lock nut and a threaded split ring. The bearing is easily applied to and removed from the roll neck as a unit, without separation of the assembly, so that the highly-finished operating parts are always protected against dirt and injury.

(Fig. 1)—Cross Section view of Morgoil Bearing.



(Fig. 2)—Outer surface of bearing sleeve ground to a mirror finish.

During operation of the bearing, oil supplied by a circulating system is introduced between the sleeve and bushing in such a manner that the bearing surfaces are always separated by an unbroken film of lubricant. Oil is also supplied to lubricate the double-acting thrust bearing, as well as the roll neck itself. After leaving the bearing surfaces, the oil flows into drain pockets at the bottom of the casing and is returned through drain pipes to the oil reservoir. In order to insure perfect lubrication even with a very thin oil film, the outer surface of the bearing sleeve is ground to a mirror finish, as illustrated in Figure 2, while the babbitted bearing surfaces are finished to precision dimensions with a diamond tool. This precise workmanship enables our bearings to carry extremely heavy loads without metallic contact, and with coefficients of friction varying from .001 to .003.

Figure 3 shows first installation of Morgoil Bearings on continuous hot strip roughing mill.

From the construction illustrated in Figure 1 it will be clear that each Morgoil bearing is capable of carrying axial thrust loads in either direction. For this reason the bearings on the working side of the mill only are clamped to the roll housing. These bearings may be clamped in a fixed position with respect to the housing, or if axial adjustment of the roll is required to align passes, the bearings may be held in place with adjustable clamps. The Morgoil bearings on the drive side of the mill are not clamped to the roll housing, but are left free to float as required by expansion and contraction of the rolls. The thrust rings in the latter bearings serve to locate the bearing casings with respect to the roll necks, thereby avoiding the need for any other form of tie between bearings.

Our bearings are constructed in two different types. The straight-neck type bearing described above and illustrated in Figure 1, was developed in September 1933. It employs a cylindrical roll neck and a bearing sleeve having a uniform bore. In this bearing the sleeve is mounted on the roll neck with a sliding fit, and creeps around the neck very slowly as they rotate. With tapered-neck type of Morgoil bearing, the bearing sleeve is constructed with a tapered bore and is keyed to the roll neck.

Among the numerous applications of our bearings there are several which merit particular attention. The continuous hot strip roughing mill illustrated in Figure 3 represents the first installation of Morgoil bearings in actual practice. These bearings were installed early in 1932, and have assisted since that time in the production of more than 400,000 tons of steel strip, including a considerable proportion of stainless steel. Inasmuch as the rolling practice in this pioneer application is unusually severe, the consistently flawless performance of the bearings since their installation is especially gratifying.

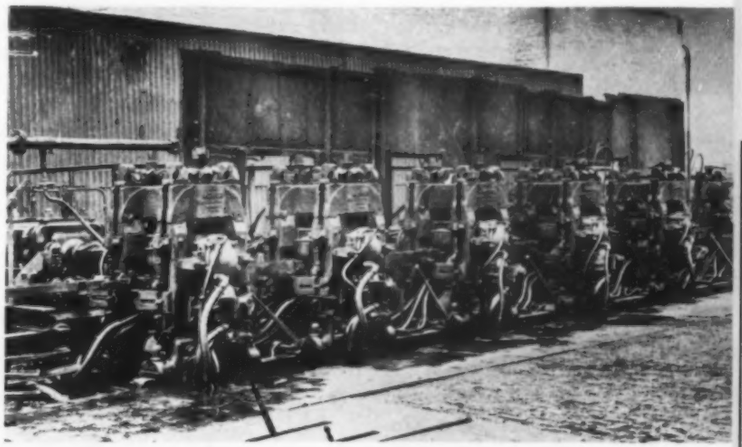
Another continuous hot strip mill is shown in Figure 4. The Morgoil bearings were installed in this mill early in 1933, replacing conventional grease-lubricated brass bearings. The results obtained in this installation are particularly noteworthy, because of the fact that very accurate records of production and cost were kept both before and after the application of Morgoils. In addition to power savings ranging from 45 to 60%, as compared to their previous practice on the same rolling schedules, the operators credited our bearings with an increase of 1½% in the average yield.

Figure 5 illustrates a set of straight-neck Morgoil bearings which are operating in an 18 inch two-high cold mill used for the dry rolling of brass strip. Here one of the principal requirements is that the bearing lubricant must be restrained positively from reaching the surface of the rolled strip. The success of this Morgoil application throughout two years of operation indicates the effectiveness of the oil seals and drainage facilities employed with our bearings.

A few weeks ago a new rod mill was put into operation, equipped with our bearings throughout. The elimination of unnecessary frictional losses enables this mill to roll two simultaneous strands of No. 5 rod from 2 inch billets with a total power consumption of less than 80 kilowatt hours per ton of product.

A particularly interesting application of our bearings was made a few months ago in a two-high reversing hot strip mill of the Steckel type. This mill, originally equipped with roller bearings, was changed over to our bearings in order to provide adequate bearing capacity without sacrifice of roll neck strength. The use of our bearings, although offering no noticeable power saving in comparison to the previous practice, permitted the roll neck diameter to be increased greatly, thus removing the hazard of neck breakage and eliminating the sole obstacle to the profitable operation of this mill.

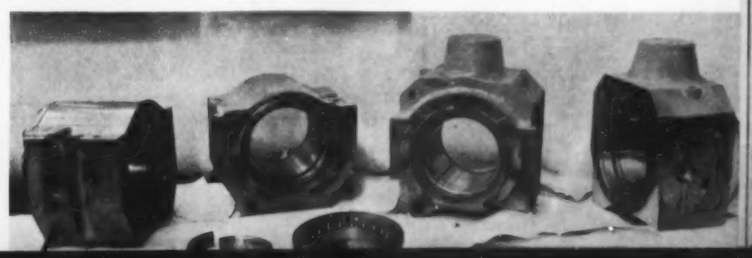
The smallest Morgoil bearings which have been constructed are operating on the roll necks of an 8-inch two-high cold rolling mill. This mill, which was previously equipped with bearings having insufficient capacity, produces high-carbon and stainless steel strip. Since the application of Morgoils, no difficulty has been experienced in following the desired rolling schedules.



(Fig. 4)—Continuous strip mill using Morgoil Bearings.

Figure 6 shows a set of Morgoil Bearings for a Four-high cold rolling mill.

(Fig. 5)—Bearings for 18 inch two-high cold mill.



In Figure 6 is shown a set of comparatively large Morgoil bearings which have been operating for more than two years on the backing rolls of a four-high cold rolling mill. This mill produces sheet steel in widths up to 55-inches, and is loaded very heavily in relation to the roll diameter.

Our bearings are constructed for rolls of all sizes from 8-inch to 54-inch diameter. From the standpoint of theory there is no factor which defines any limit to the life of these bearings and in every application they may be expected to carry capacity loads continuously for an indefinite length of time, without replacement and with a minimum of frictional loss. Conclusive evidence of the durability of our bearings has been furnished by nearly four years of successful operation in the original installations.

▲

DISCUSSION*

PRESENTED BY

C. C. PECU, Lubrication Engineer, Bethlehem Steel Co., Lackawanna, N. Y.

J. H. HITCHCOCK, Morgan Construction Co. Worcester, Mass.

M. STONE, Engineering Department, United Engineering & Foundry Co., Pittsburgh, Pa.

MYLES MORGAN, Morgan Construction Co., Worcester, Mass.

H. M. RICHARDSON, Plastics Dept., General Electric Company, Lynn, Mass.

Chairman Pecu: Does anyone wish to ask Mr. Hitchcock any questions on this subject? I would like to ask what viscosity of oil do you recommend for different sizes, necks and speeds?

J. H. Hitchcock: The viscosity of oil chosen depends entirely upon conditions of each application with respect to load and speed. The viscosity recommended usually lies between 1000 and 2000 seconds Saybolt at 100 degrees.

C. C. Pecu: What quantity or percentage of water will the film strength hold up under?

J. H. Hitchcock: That is a question which I am unable to answer in detail. There is only one Morgoil installation where trouble was experienced with the entrance of water. The difficulty in that installation, which was one of the earliest, was due to the peculiarities of the mill construction. In that case, water amounting to fifty percent of the total quantity of lubricant was present. In some other installations there is some small quantity of water present, but the quantity is so small that no trouble is experienced.

* Discussion of paper presented by J. W. Hitchcock.

C. C. Pecu: Did you not have even eight or ten percent and your bearings were not destroyed?

J. H. Hitchcock: It is true that in early installations water amounting to eight or ten percent has been present for considerable periods of time without impairing the performance of the bearings.

M. Stone: I would like to have commented on the two figures of coefficient of friction mentioned in Mr. Hitchcock's paper and in a paper on water lubricated fabric bearings. Mr. Hitchcock mentioned that the coefficient of friction in film lubricated bearings is maintained between .001 and .003—dependent on the proper combination of speed, load and viscosity. For the water lubricated fabric bearings, where conditions for the establishment of an hydro-dynamic film do not exist, it has always amazed me that coefficients as low as .002 could be realized. Could Mr. Hitchcock, or possibly better, the author of the paper containing the latter information, offer an explanation of these values?

J. H. Hitchcock: Unfortunately, I am unable to answer that.

C. C. Pecu: What pressure of oil do you require for the initial pressure in the bearing?

J. H. Hitchcock: The pressure required for the oil entering the bearing is purely nominal. We ordinarily specify a pressure of 20 to 30 pounds per square inch. That is merely a matter of specification and is not essential to the operation of the bearing. The thing that is essential is that oil be introduced to the inlet of the bearing surfaces in sufficient quantity to lubricate these surfaces properly. If the hole were big enough, the oil could be poured in with an oil can at atmospheric pressure.

C. C. Pecu: For the different diameters of roll necks what clearance do you allow in the bearings?

J. H. Hitchcock: On intermediate sizes of bearings the clearance is one and one-quarter thousandths per inch of diameter.

M. Morgan: Pardon me, I think Mr. Hitchcock misunderstood your question. You asked regarding the clearance between the neck and the surface of the inner sleeve? That depends upon the size of the bearing—for instance on a 24″ neck, it is approximately twelve thousandths.

J. H. Hitchcock: I thought you were referring to the clearance between the sleeve and the bushing.

C. C. Pecu: What I am after is this—the difference in the diameters of roll necks and the diameter of the bearing bore. Your answer is one and a quarter thousandth for every inch of roll neck is the clearance in the bearing.

J. H. Hitchcock: In speaking of roll neck diameter, I assume that you are not for the moment considering the roll neck itself. The diameter of the bearing surface is the outside diameter of the sleeve. The clearance between the outside of the sleeve and the inside of the bushing is one and a quarter thousandths per inch of diameter.

A Member: I would like to ask whether that bore of the babbitt is scraped?

J. H. Hitchcock: It is not scraped, it is bored to precision dimensions with a diamond tool.

A Member: I think I may be able to offer some explanation to Mr. Stone's question on why non-

metallic bearings apparently operate on such low co-efficient of friction. You must consider that the non-metallic or the laminated type has a very low modulus of elasticity, about one-half million, which makes it about six times as elastic as steel, so that the pressure built up on the lubricating film is sufficient to cause considerable compressive deflection relative to the thickness of the film. Thus the conventional relation between the diameter of the journal and the diameter of the bearing itself may be altered in such a way as to equalize the pressure throughout the bearing area. In other words, the average film pressure would probably be the same in the case of two metallic surfaces such as steel and babbitt, but probably the maximum film pressure is less on the water film than it is on the oil film owing to the compressive deflection of the bearing itself. Fabric to metal contact still occurs. That means the low co-efficient is obtained in spite of the actual physical contact.

In some cases we have found that bearings that have run for a considerable length of time without stopping develop perhaps a dark color on the surface of the neck which stays there so long you have lubrication but when the film breaks down, that rubs off. At those times a greater amount of wear takes place.

M. Morgan: I would like to ask Mr. Richardson a question. In connection with phenolic resin bearings, with the exception of installations on the high speed end of rod mills where the load is light and the speed is high, how is it possible to obtain film lubrication with water when water has an absolute viscosity of only one?

H. M. Richardson: Probably at the lower speeds such water film lubrication is not present. According to all the tests we have made, the coefficient of friction starts to rise very rapidly when the rubbing speed gets below 400 feet per minute. This indicates to us a partial breaking down of the water film.

C. C. Pecu: I would like to ask Mr. Morgan or Mr. Hitchcock how low a speed you have been able to run with your Morgoil bearings and under what pressure?

M. Morgan: Experimentally, on the test floor of our shop, we have taken a pair of rolls in a housing, screwed the rolls together with pressure gauges under the screws and loaded the rolls and bearings up to the maximum load which the roll necks could carry. In fact we broke a lot of rolls. Under those conditions, if we used a sufficiently heavy viscosity oil, we could run as low as three R.P.M. continuously without failure of the oil film.

C. C. Pecu: Your pressure was what?

M. Morgan: As much as the rolls would stand.

C. C. Pecu: Did you not have a million pounds at one time?

M. Morgan: That depends on what size of rolls and bearings we were experimenting with.

C. C. Pecu: I wanted to bring out just how low a speed at which you possibly could run. I remember at one time you ran a test for 96 hours at practically a little over three R.P.M. and it did not make a metal contact, with an 800 viscosity oil.

A Member: I would like to know the experience of any of the men here as to the application of the lubricant on composition bearings at any other place than the point where the roll neck enters the bearing. In other words, bringing water into the bearing like you have brought oil into the Morgoil bearing at definite places. In other words, establish a film all the way around, I also want to know if any Morgoil bearing has been designed to use only babbitt as a liner where the bronze or composition materials have been used.

M. Morgan: We have tried bronze very unsuccessfully. In fact, I don't know of any bronze bushings that have run more than twenty-four hours. We had no success at all, although we tried different analyses of bronze, copper-lead mixtures, and all of the typical so-called bearing bronzes.

A Member: How about composition materials, have you used any of them?

M. Morgan: No, we have not.

A Member: Why? If you have the perfect lubrication, that is continuous film, the material you used for the soft metal wouldn't make any difference whatsoever.

M. Morgan: The only explanation we can give to that is that no matter how accurately you try to machine any parts, particularly in a bearing, some irregularities will be present. A soft bearing metal is very hard to machine accurately, much harder than a hard metal. However, even an accurately ground steel journal is certain to contain a few hills and valleys. When a new bearing is started, let us say there is a hill in some spot which might cut through the oil film. If a soft bearing metal is used, the hill will immediately push off into a valley and the oil film re-establish itself. Our explanation for the failure of bronze bushings is based on the high coefficient of expansion of bronze. If the oil film is broken by a small high spot in a new bronze bushing, the material at that point expands so rapidly from the heat generated that the area of imperfect lubrication is rapidly increased, until it spreads over the entire bearing. In other words, there is no corrective action such as occurs with softer bearing metals.

A Member: That means that the low modulus in the babbitt is a helpful factor when you get down to very thin material.

M. Morgan: Yes, it is the reason we use a thin layer.

A Member: The old theory put babbitt in three-quarters of an inch. I have seen some up to an inch thick and that is not so good.

DISCUSSION*

PRESENTED BY

C. C. PECU, Lubrication Engineer, Bethlehem Steel Company, Lackawanna, N. Y.

F. L. ESTEP, Vice Pres., Perin Engineering Company, Inc., New York, N. Y.

L. F. COFFIN, Supt., Mechanical Dept., Bethlehem Steel Company, Sparrows Point, Md.

C. C. Pecu: If there are any questions to be asked, they will be asked at this time. The discussion is the main light of every paper. I have asked many questions and I have criticized these men. I think that we, as an operating force, should honor these men due to the fact that they pioneered in the work. At first we did not believe in them, but they have been persistent, and now we have to accept the fact that it is a good proposition.

F. L. Estep: I have just come back from India. We took a three-high rougher out there last winter and for this mill we took the Ryertex Bearings for top and bottom necks, for carrier, for the top roll and for side bearings for top and bottom. Now, the first gentleman, in his paper, speaks of the temperature at which the bearings were tested.

We had all sorts of trouble with our bearings out there. We tried everything we knew. They did not have filtered water originally. We spent about $10,000 and put in an individual filter system for the mill; we increased the pipe from two to four inches; we changed the nozzles; we did everything we knew. We discovered one thing that maybe some of you have discovered, particularly if you have to have your bearings shipped a long distance. They were shipped nested, the bearings having a difference of about an inch in the radius inside versus the outside. Evidently, in the travel across the ocean ten or fifteen thousand miles, the bottom bearings as nested flattened out a little. We didn't know that until we went to put them in. We didn't know why they wouldn't pull up. The next bearings we had shipped out in holders, clamped together exactly as they came out of the mold, and sent out to the job that way.

We began taking temperatures of the water. Our arc of contact on the main bearings was 108°, and we had side bearings; therefore the amount of surface of neck exposed to water was perhaps less than some of the cases here. Our water temperature inlet was from 96° to 99° maximum. The maximum temperature of the discharge water which we were able to catch was 110°. We also had a hole through the top roll, and had the temperature taken time and time again and it was 146° maximum. We couldn't keep the bearings in the mill. We wore out the original set of 6, the first spare set of 24, and a new spare set of 24, which makes 54 bearings total since the first of April. We couldn't keep the tonnage of the mill up—we couldn't keep the bearings in, and we put in an improvised bearing I sketched up for them the Sunday before I left. These were put in on August 1st. The following Saturday was the 3rd, and the next Saturday was the 10th, and the tonnage on that mill from August 5th to date has gone up 25%. I am responsible for taking the Ryertex bearings out there. I talked it over with the makers and I told them I wanted a solution. That has been my experience, now let somebody else come across.

L. F. Coffin: I am very much interested in Mr. Estep's experiences. We have at Sparrows Point 2—Three High Sheet Mills of similar design to the mill Mr. Estep refers to, our first mill went into service in September, 1933 and operated on brass bearings for three weeks at which time the bottom bearings were worn out. Since that time that mill and the second mill which we installed in June 1935 operated continuously on Ryertex, Textolite and Micarta Bearings. We use cold fresh water at 62° F. Sparrows Point is a tidewater plant and our normal cooling water, however, is salt water of about half the salt content of sea water. In the summer time this salt cooling water reaches temperatures up to 85° F. and after passing through our turbo generator surface condensers, it gets up to 100° F. We found shortly after commencing the use of composition bearings in our plant that 100° F. salt water was not satisfactory for these bearings. We are not prepared to state whether 100° F. fresh water would be satisfactory. We do know, however, that Lignum Vitae Bearings will operate and are operating on fresh and salt water up to 100° F. The tests which Mr. Richardson described showing that apparently composition bearings will operate without materially increased friction up to temperatures greatly in excess of 100° F., may not represent the actual conditions that would apply in operation inasmuch as they were made on a very small journal (2″ dia.) on which the total length of the arc of contact could not begin to compare with that in the Three High Sheet Mill or Plate Mill. We have in our plant, one mill operating on composition bearings with 32″ journal diameter.

The problems that have been raised by these papers and others seem to point out that Manufacturers, Users (possibly the Association of Iron and Steel Electrical Engineers) and possibly in cooperation with the Bureau of Standards should organize a real research laboratory for the solution of the many problems in connection with the use of these bearings. It would appear to me that there are certainly more than two phases to this situation.

There is a problem of length of arc of contact, of material in the necks, the use of graphite in bearings, the temperatures and quantities and type of water, the method of distribution of water, etc. As for graphite, I am inclined to believe that in some bearings, graphite is a detriment, particularly on high speeds, whereas in other applications it would appear to be necessary. The thought I wish to leave then is that research be continued so that the Iron and Steel Industry may know why these bearings work so that the Manufacturers may still further improve their product.

C. C. Pecu: Mr. Coffin has gone into everything in detail and has made a special study of these bearings. What he has done we can follow in most places.

*Discussion of papers presented by H. M. Richardson, K. T. MacGill and H. F. Horne.

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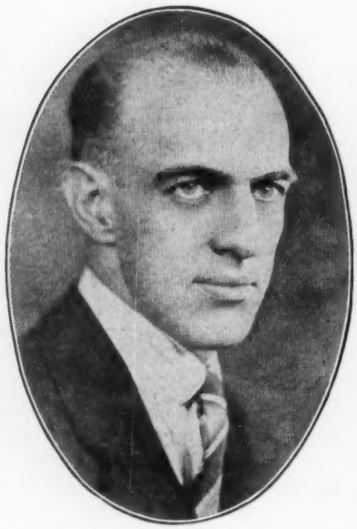

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R. S. Shoemaker, Supt. Rolling Mills, American Rolling Mill Co., Middletown, Ohio.
D. A. Keating, Chief Engineer, American Tube & Stamping Company, Bridgeport, Conn.
H. G. R. Bennett, Asst. General Supt., Carnegie-Illinois Steel Corp., Duquesne, Penna.
A. E. Miller, General Supt., Allegheny Steel Company, Brackenridge, Penna.
C. L. McGranahan, Supt., Hot Strip Mill, Inland Steel Company, Indiana Harbor, Ind.
W. S. Hall, Asst. Gen. Supt., Carnegie-Illinois Steel Corp., South Chicago, Ill.
J. A. Brua, Supt., Strip Mill, Ford Motor Company, Detroit, Mich.
H. A. Baugh, Supt., Bar Mills, Carnegie Illinois Steel Corp., Youngstown, Ohio.
Stevenson Findlater, Supt., Seamless Mills, National Tube Company, McKeesport, Penna.
J. Gordon Gage, Gen. Supt., American Rolling Mill Co., Butler, Penna.
Stephen Badlam, Consulting Engineer, Farmers Bank Building, Pittsburgh, Penna.
John H. Vohr, Supt., Hot Strip Mill, Youngstown Sheet & Tube Company, Youngstown, Ohio.
F. L. Estep, Vice President, Perin Engineering Co., Inc., New York, N. Y.
J. H. Van Campen, Chief Engineer, Republic Steel Corp., 3100 E. 45th St., Cleveland, Ohio.
Hugh B. Conover, Asst. Gen. Supt., Carnegie-Illinois Steel Corp., Mingo Junction, Ohio.

ROLLING MILL EQUIPMENT SECTION

Chairman: F. E. Flynn, Gen. Supt., Republic Steel Corp., Warren District, Warren, Ohio.
J. H. Kalberkamp, Chief Draftsman, Mesta Machine Company, Homestead, Penna.
L. Douglas Smith, Vice President, Lewis Foundry & Machine Co., Groveton, Penna.
R. J. Wean, President, Wean Engineering Company, Inc., Warren, Ohio.
W. R. Duda, Chief Engineer, Mackintosh-Hemphill Company, Pittsburgh, Penna.
C. L. Taylor, Vice President, Aetna-Standard Engineering Co., Youngstown, Ohio.
R. H. Ellis, Elec. Engr., United Engineering & Foundry Co., Pittsburgh, Penna.
E. Peterson, Chief Engineer, Birdsboro Steel Foundry & Machine Co., Birdsboro, Penna.
H. H. Wood, Sales Manager, Morgan Construction Company, Pittsburgh, Penna.
Q. S. Snyder, President, Pittsburgh Rolls Corporation, Pittsburgh, Penna.
L. W. Nash, General Manager, E. W. Bliss Company, Salem, Ohio.
F. H. Barnard, Sales Engineer, Morgan Engineering Company, Alliance, Ohio.
Lloyd Jones, Vice President, Continental Roll and Steel Foundry Co., Pittsburgh, Penna.
Austin Kuhns, Mech. Engr., Farrell-Birmingham Co., Inc., Buffalo, N. Y.
T. M. Rees, President, Rees Machinery Co., Pittsburgh, Penna.

SPECIAL BEARING SECTION

Chairman: F. D. Egan, Elec. Supt., Bethlehem Steel Co., Lackawanna, N. Y.
S. M. Weckstein, Assistant Chief Engineer, Timken Roller Bearing Co., Canton, Ohio.
Geo. S. Warren, Chief Engineer, Sharon Steel Hoop Company, Sharon, Penna.
G. Palmgren, Chief Engineer, SKF Industries, Inc., Philadelphia, Penna.
L. F. Coffin, Supt., Mechanical Department, Bethlehem Steel Co., Sparrows Point, Md.
J. M. Kelly, Engineer, Hyatt Roller Bearing Company, Pittsburgh, Penna.
W. M. Hilditch, Gen. Master Mech., Great Lakes Steel Corp., Ecorse, Michigan.
A. H. Frauenthal, Chief Engineer, Bantam Ball Bearing Company, South Bend, Ind.
H. F. Martin, Gen. Master Mech., Jones and Laughlin Steel Corp., Aliquippa, Penna.
Samuel Farrell, Sales Engr., Rollway Bearing Company, Pittsburgh, Penna.
T. French, Ass't. Supt., Mechanical Dept., Youngstown Sheet & Tube Co., Youngstown, Ohio.
A. E. Rosenquist, Design Engr., Carnegie-Illinois Steel Corp., Duquesne, Penna.
D. E. Batesole, Asst. Engr. Mgr., Norma-Hoffmann Bearing Corp., Stamford, Conn.
J. A. Burg, Mech. Engr., Carnegie-Illinois Steel Corp., Homestead, Penna.
Myles Morgan, Asst. Chief Engr., Morgan Construction Co., Worcester, Mass.
S. N. Roberts, Elec. & Mech. Supt., Atlantic Steel Company, Atlanta, Ga.
F. W. Voght, Engr., Jos. T. Ryerson & Son, Inc., Philadelphia, Penna.
C. J. Duby, Chief Engr., Republic Steel Corp., Warren, Ohio.
L. A. Cummings, Chief Engineer, Marlin Rockwell Corp., Jamestown, N. Y.
B. S. Burrell, Gen. Master Mech., Inland Steel Company, Indiana Harbor, Ind.
J. L. Young, Asst. Gen. Mgr., Industrial Div., Timken Roller Bearing Co., Canton, Ohio.
J. S. Murray, Chief Elec. Engr., Follansbee Bros., Co., Follansbee, W. Va.
L. M. Wampler, Elec. Foreman, National Tube Co., McKeesport, Penna.
R. M. Backus, Gen. Master Mechanic, Carnegie-Illinois Steel Corp., Youngstown, Ohio.

TRANSPORTATION & MATERIAL HANDLING SECTION

Chairman: G. N. Harmon, Elec. Supt., Republic Steel Corp., Warren District, Warren, Ohio.
D. M. Petty, Supt. Service Divisions, Bethlehem Steel Company, Bethlehem, Penna.
A. H. Candee, Transportation Engr., Westinghouse Electric & Manufacturing Co., Philadelphia, Penna.
G. H. Criss, Sales Engr., H. E. McCoy Company, Pittsburgh, Penna.
L. W. Long, Supt. of Maintenance, National Tube Company, Lorain, Ohio.
J. K. Mahaffey, Pittsburgh Dist. Mgr., Edison Storage Battery Company, Pittsburgh, Penna.
C. H. Moeller, Dist. Mgr., Yale & Towne Mfg. Company, Pittsburgh, Penna.
L. N. Crissman, Sales Engr., Electric Storage Battery Company, Pittsburgh, Penna.
C. B. Cook, Sales Mgr., Elwell Parker Electric Company, Cleveland, Ohio.
H. G. Hague, Elec. Supt., American Sheet & Tin Plate Company, Gary, Ind.
R. S. Richards, Sales Engr., Atlas Car & Mfg. Company, Cleveland, Ohio.
L. F. Meissner, Sales Engr., Mercury Mfg. Co., Pittsburgh, Penna.
M. Nesbitt, Automatic Transportation Company, Pittsburgh, Penna.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS

PHILADELPHIA SECTION

Meetings and Papers for 1935-36

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SATURDAY, NOVEMBER 2, 1935

"*Designing for Lubrication*", C. R. Hand, Lubricating Engineer, Bethlehem Steel Company, Sparrows Point, Md.

SATURDAY, DECEMBER 7, 1935

"*Ventilation of Rolling Mill Motors and Motor Rooms*", H. H. Angel, Electrical Department, Bethlehem Steel Company, Sparrows Point, Md., C. B. Huston, Industrial Engineering Department, General Electric Company, Schenectady, N. Y.

SATURDAY, JANUARY 4, 1936

ANNEALING FURNACE SYMPOSIUM

"*Controlled Atmosphere and Fuel Fired Bright Annealing*", A. L. Hollinger, Assistant Sales Manager in Charge of Steel Mill Division, Surface Combustion Corp., Toledo, Ohio.

"*Bright Annealing of Strip by the Batch Method*", J. W. Allison, Industrial Heating Engineer, Westinghouse Electric & Manufacturing Company, Philadelphia, Penna.

"*Controlled Atmosphere in Electrically Heated Furnaces*", Harold E. Trent, President, Harold E. Trent Company, Philadelphia, Pa.

During the afternoon the members and their guests are invited to visit the Franklin Museum and Fels Planetarium on the Parkway.

SATURDAY, FEBRUARY 1, 1936

"*Application of Waste Heat Boilers and the Production of Power From Waste Gases From Large Gas Engine Installations*", T. A. Lewis, Combustion Engineer, Bethlehem Steel Company, Bethlehem, Penna.

SATURDAY, MARCH 7, 1936

"*Modern Lighting Technique in Steel Mills*", Walter Sturrock, Illuminating Engineer, General Electric Company, Nela Park Engineering Department, Nela Park, Cleveland, Ohio.

SATURDAY, APRIL 4, 1936

MAINTENANCE SYMPOSIUM

"*Preventative Maintenance by Periodic Inspection*", George O. Van Artsdalen, Philadelphia, Pa.
"*Maintenance of General Purpose Motors*", George Pfeffer, Florence, N. J.
"*Maintenance of Steel Mill Equipment*", H. D. Esterly, Conshocken, Pa.
"*Maintenance Department Stockrooms*", F. O. Schnure, Sparrows Point, Md.
"*Minimizing the Hazards of Maintenance*", A. J. Standing, Bethlehem, Pa.

All meetings will be held in the Engineers' Club, 1317 Spruce Street, and will start promptly at 7.00 P.M. They will be preceded by an informal dinner at 6.00 P.M.

▲ ▲ ▲ ITEMS OF INTEREST ▲ ▲ ▲

Ross L. Leffler has been appointed the manager of Industrial Relations for the Pittsburgh district of the Carnegie-Illinois Steel Corporation. He will also have in his department, safety, welfare, and employment.

Mr. Leffler's service with the Corporation began in 1910 at the Duquesne Works of the Carnegie Steel Company, and has been continuous, having served in the Roll Department as Clerk, Assistant Foreman, and Assistant Superintendent, until July, 1931, when he was appointed Superintendent of Rolling Mills, Roll and Chipping Departments. In August, this year, he was appointed Superintendent of the Safety, Welfare, and Employment Department.

In consequence of his long and varied experience in contact with steel men, he comes to his new and important assignment with the proper background and a knowledge of the problems of industrial relations.

Mr. Leffler is a graduate of the University of Michigan and a member of the Pennsylvania State Game Commission, having served as its President from 1927 to 1931.

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Jerome R. George, Jr., has been elected the president of the Aetna-Standard Engineering Company, Youngstown, Ohio. Before coming to Youngstown, Mr. George was vice-president of the Morgan Construction Company, Worcester, Mass. M. I. Arms, who had been president, was elected vice president of the Aetna-Standard Company.

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Keith J. Evans has been appointed manager of the sales promotion division of the Inland Steel Company. He will be in charge of the company's advertising and other merchandising affairs. This is the same capacity in which he served for the Joseph T. Ryerson & Son, Inc., since 1917 and will continue to do so in addition to his association with the Inland Company.

The Carnegie-Illinois Steel Corporation, through its C. V. McKaig, vice president and general manager of sales, announce the following changes in the sales department.

David F. Austin as Manager of Sales of the Chicago District Office. Mr. Austin, who, since 1933, has been Manager of Sales of the Pittsburgh District Sales Office, began his career with the United States Steel Corporation in 1918 with the Federal Ship Building Company. His affiliation with Carnegie Steel Company's Sales Department commenced about eight years ago, during which time he held, successively, the positions of Assistant Manager of Sales and Manager of Sales of the Cincinnati District Sales Office, before being transferred to Pittsburgh.

T. Lane Watson as Manager of Sales of the Western Area, Bar Strip and Semi-Finished Materials Division, with offices in Chicago. Mr. Watson entered the service of Carnegie Steel Company in 1910 in the General Sales Department, Rail and Billet Bureau. He was appointed Assistant Manager, Bar Strip and Semi-Finished Division on Nov. 1, 1932, and Assistant Manager of Cleveland District on April 1, 1935.

Leslie B. Worthington as Manager of Sales, St. Paul District. Mr. Worthington entered the employ of the Illinois Steel Company immediately after his graduation from the University of Illinois in 1923. Following a period of apprenticeship at the South Chicago Works, he entered the General Sales Department of the Company, where he was employed in various capacities until June 15, 1934, when he was appointed Assistant Manager of Sales of the Chicago District Office.

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T. E. Millsop, formerly vice president of the Weirton Steel Company, has been appointed executive vice-president of the company. Prior to serving the company as vice-president, Mr. Millsop had been the assistant to Mr. J. C. Williams, President.

ROSS L. LEFFLER

T. E. MILLSOP

Arthur A. Aranson, as announced by F. B. Hufnagel, President, has been appointed to the position of assistant to the president of the Crucible Steel Steel Company of America.

For the last 30 years Mr. Aranson has been associated with the International Harvester Company, which he joined in 1906 at the age of twenty-one. Working his way through the ranks, Mr. Aranson has been identified with various important positions in the Harvester Company, both in Canada and in the United States, and in all these positions has been prominently identified with the selection and purchase of the largest tonnage of steel used by the implement industry.

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Homer D. Williams, president of Pittsburgh Steel Company, announces his retirement to be effective February 1, 1936.

Serving a total of 55 years in the steel industry, Mr. Williams has been successively employed by the Cambria Steel Company, Illinois Steel Company, Colorado Fuel & Iron Company, Maryland Steel Company, and the Carnegie Steel Company which he headed up as president from 1915 till 1925 when he became president of Pittsburgh Steel Company.

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HENRY E. DAVIS

Henry E. Davis, formerly superintendent of the electrical and mechanical departments, Republic Steel Corporation, Chicago, Illinois, has been appointed to the same capacity at the Buffalo Plant of the Republic Company.

At the present time Mr. Davis, long an active member of the association, is serving as the chairman of the membership committee.

WITH THE MANUFACTURERS

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A new Westinghouse equipped electrically operated 7-foot diameter turntable suitable for revolving 6-ton coils of strip steel prior to pickling, is announced by the Mathews Conveyor Company, Ellwood City, Pa.

The unit is driven by a 5 HP 1200 R.P.M. 3 phase, 60 cycle, 220 volt motor coupled to a vertical speed reducer and spur gears. Its purpose is to receive from a straight line of conveyors 12,000 lb. Coils of Strip Steel, which are placed on the conveyer from coil storage at random. The turntable serves to place the coils of steel with their fish tails (or loose ends) in proper position to enter continuous pickler. Since the coils are conveyed on their side, core axis horizontal, a troughed section of heavy duty conveyor is used to handle this circular shape. The individual rollers in the conveyer section are ball bearing—grease packed type fitted with grease fittings for periodical lubrication. The rollers are 3⅝″ diameter, each having a continuous load rating of 2000 lbs.

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Norma-Hoffmann Precision Needle Roller Bearings" is the title of a new bulletin just issued by Norma-Hoffmann Bearings Corporation, Stamford, Conn., and describing the latest addition to this manufacturer's line of Precision Bearings. This type of bearing—employing a large number of long rollers of small diameter—has found increasing favor in recent years for purposes where considerations of space forbid the use of the conventional type of anti-friction bearing. They commend themselves particularly to conditions where minimum outside dimensions, minimum weight, concentrated load capacity and inherently high quality are requisites. Typical applications are:—connecting rod bearings (wrist pin end); cam rollers, rocker arms, pump shafts, idler gears, planetary reduction gears; aircraft engines; printing machinery; miscellaneous machine purposes. Norma-Hoffmann Precision Needle Bearings, in metric sizes from 12 to 150 m/m bore, are adapted to a wide range of loads and speeds.

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The Bristol Company announces, as an addition to its line of industrial instruments, the Wide-Strip Pyrometer, which is available in single-record, multiple-record and recorder controller types. This instrument, operating on the potentiometer principle of temperature measurement, has a built-in accuracy that commands attention. This accuracy is made possible through an almost unbelievably simple measuring, balancing, and recording mechanism.

A stainless steel lead screw, operated by an electrical motor under the direction of two galvanometer-controlled contacts, adjusts the slide-wire contact and recording-pen unit to maintain emf balance in the potentiometer system. This mechanism introduces an entirely new principle of operation into temperature measurement by means of the potentiometer method.

The unique design of the balancing mechanism is such that all mechanical backlash is taken up, mak-

ing it possible to magnify scarcely perceptible deflections of the galvanometer pointer. No clearance is required between the pointer and the chopper arms. Deflections smaller than 1/1000 of an inch are easily measured.

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"Farrel-Sykes Gear Generators" is the title of a new book which has just been published by Farrel-Birmingham Company, Inc., 344 Vulcan St., Buffalo, N. Y.

Although primarily a catalog of the Sykes Gear Generating Machines, the book also deals with the theory of gear generation, with particular reference to the Sykes process and its advantages as compared to others. The book explains the design and construction of the Sykes machines, their set-up and operation, gives details of specifications and capacities of the various sizes, and describes and illustrates the numerous types of gears and toothed forms that can be generated on the Sykes machines. Information on the design and manufacture of the cutting tools used in Sykes machines and the method of sharpening them is also given.

The book also includes sections on the importance of lapping gears and the measuring and testing of gear teeth in order to produce the most accurate and smoothly finished gears that will operate silently and have maximum load carrying capacity and durability. Another section of interest gives a brief history of the development of the Sykes machines, for which the inventor, William E. Sykes, was awarded the Edward Longstreth Medal by the Franklin Institute, of Philadelphia, in 1934.

The book is essentially a condensed treatise on gear manufacture and its fifty-two pages, illustrated by eighty photographs and diagrams, contain much helpful information for engineers and operating executives who are responsible for the production of gears.

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Thirteen big bell-type electric furnaces, larger than any of this type heretofore constructed, will soon be installed by the General Electric Company in the Rouge Plant of the Ford Motor Company where, in conjunction with twelve other bell-type furnaces built by another manufacturer, they will be used to anneal steel strip for the Ford V-8. Each is of sufficient capacity to bright-anneal, in one charge, two 16,000-pound coils of steel strip 48 inches wide, 52 inches outside diameter and 30 inches inside diameter. A number of the furnaces had already been shipped to the Ford plant by late September, while those still in the course of construction were inspected with interest by Henry Ford on the occasion of his recent visit to the G-E Schenectady Works.

The purchase of the large furnaces is based on results of tests made in a G-E furnace of this type which was installed in the Ford plant early this year. The test furnace demonstrated the ability of the bell-type electric furnace to produce steel of superior qualities in a short annealing time and at low cost. The steel has better ductility (deep drawing properties), better uniformity, and comes through the furnace bright and clean. The annealing cycle is in the neighborhood of 45 hours—much shorter than with conventional fuel-fired equipment.

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A new booklet illustrating and describing all the newest developments in arc welding electrodes and accessories is announced by The Lincoln Electric Company, Cleveland, Ohio.

This booklet is virtually a condensed manual on arc welding. Complete descriptions, applications and procedures are given for electrodes for all welding purposes—for mild steel, high tensile steel, light-gauge steel, 18-8 stainless steel, 25-12 stainless steel, high manganese steel, cast iron, aluminum; for hard facing to resist moderate shock and abrasion, rolling or sliding abrasion, impact and severe abrasion, and for making tool-steel cutting edges. The complete procedures for each electrode give the polarity, current range, arc volts for every size of every electrode in every welding position.

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The Ford Motor Company has purchased twelve annealing furnaces together with 36 bases and metal hoods from the Westinghouse Electric & Manufacturing Company for use in conjunction with their new strip mill. Rated at 230 kw. each furnace will anneal two coils of strip 52 inches outside diameter. 30 inches inside diameter and 48 inches high in each charge. The strip will be used for automobile bodies.

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The Foxboro Company, Foxboro, Mass., announce the recent publication of a new 20-page bulletin No. 202 covering their complete line of Potentiometer and Resistance Thermometer Controllers. Of particular interest is the description of the new Type H Drive Unit which lowers the investment cost of the Foxboro Potentiometer Controller to the lowest figure in the history of this instrument without sacrificing quality one bit.

In addition many other interesting features are illustrated and described. There are complete lists of Potentiometer and Resistance Thermometer Controller ranges to choose from, and a number of simplified wiring diagrams that enable the reader to visualize easily how an installation will look. The reader will find in this bulletin instruments to handle practically every problem of industrial high temperature control.

Copies of this bulletin will be sent promptly upon application to the Foxboro Company, Foxboro, Mass.

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A new inhibitor for which distinctive advantages are claimed, has just been announced to the trade by E. F. Houghton & Co., Philadelphia, the product being known as Ferritrol No. 100.

Based on the accepted theory that it is not necessary to attack metal to remove scale, Ferritrol No.

100 represents the outcome of years of investigations and research.

The efficiency of an inhibitor, according to statement from the Houghton Research Staff, depends on the nature of the film its ability to plate on in the presence of much disturbance, its thickness after deposition, its lack of porosity, its dielectric strength, its ability to withstand heat without breakdown and last but not least its eventual solubility in the rinse.

Working along these lines the Company's Research Department has developed an inhibitor with a strength surpassing any heretofore offered. It is heat resistant far above pickling temperatures and will not break down at 220° F.* Its use prevents pitting or loss of steel and leaves a chemically clean surface.

Another distinct advantage is the ability to use this inhibitor together with copper sulphate for coprodizing. Parts are pickled in the usual manner in tanks containing a 5% solution of sulphuric acid and the necessary amount of Ferritrol No. 100. To the contents of this tank is added a small quantity of copper sulphate.

As the scale is pickled off, the copper deposits on the steel, which will prevent rusting. It is stated that no other inhibitor allows the copper to plate on to the steel in the pickling process.

A folder describing this product is available from the above Company upon request.

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A new line of water-tight push-button master switches, mounted in molded phenolic-compound enclosures and intended for naval-type installations or equivalent industrial applications, has been announced by the General Electric Company, Schenectady, N. Y. Each unit is operated by a molded-compound lever thus protecting the operator from electrical contact with any metallic parts that might be "alive", and as many as four units may be mounted in one enclosure. The units, designated as CR2940 master switches, provide both normally open and closed circuits. Either momentary-contact units or a combination of momentary-contact and latched-in units are available.

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In order to bring up to date and increase the efficiency of five obsolete, hand-poked gas producers in its Steubenville plant, the Wheeling Steel Corporation has installed five Chapman floating agitators.

The floating agitators are continuous stirring devices that convert wasteful, hand-operated gas producers to semi-mechanical feed. They have two functions: (1) to feed the coal into the producer and distribute it evenly over the fire bed; (2) to stir the fire bed and keep it leveled off, preventing blow holes. Hundreds of these agitators have been used to modernize obsolete gas producers in steel and glass plants.

The Wheeling Steel Corporation anticipates four direct results from the installation of the agitators: increased heating value of the gas produced; less waste of gas because of uniform feed and fire bed; considerably less attention required; increased producer capacity and consequent increased furnace capacity.

The Electric Controller & Mfg. Co., announce a new line of Contactors known as the EC&M Type LTZ LINE-ARC Contactors, these units are built of light weight, quick moving aluminum alloy construction providing an entirely new standard of high speed operation.

They are made with a full floating, resiliently mounted armature which has eliminated the annoying hum and chatter caused by uneven meeting of pole faces and has also cushioned the slam on closing. In addition, this flexible union between core faces gives an added impetus in opening the contactor, causing it to drop out cleanly and quickly.

Bearings used in these contactors are of the Oilite, self-lubricating type and are of self-aligning, spherical design making it extremely easy where required to remount these contactors as part of switchboards and similar panels.

Contacts for these new contactors are made by a new and special process which has produced a metal having much greater resistance to wear, and providing much longer contact life. In addition, contact life has been increased materially over any existing standard of comparison by scientific control of the arc by the LINE-ARC principle. With this method, the arc is immediately removed from the contacts as soon as they start to separate and is transferred to the arcing plate and blowout guard where it is moved at high speed along these parts.

These contactors are built in single, double and triple pole style and are arranged for terminal connections either at the front or rear of the contactor base.

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Radically improved in design, the new Flexarc d.c. welder recently announced by the Westinghouse Electric & Manufacturing Company embodies many improvements not found in any previous apparatus. Equipped with a single dial preset control with which the welding current can be set to the exact number of amperes, this welder is able to maintain an absolutely constant arc in spite of speed changes of the driving motor caused by line fluctuations. Open circuit voltage, well below hazardous values, provides safety for the operator yet retains all the desirable arc characteristics usually associated with high open circuit voltage. The moment the arc is struck, the set adjusts itself immediately to the required preset value.

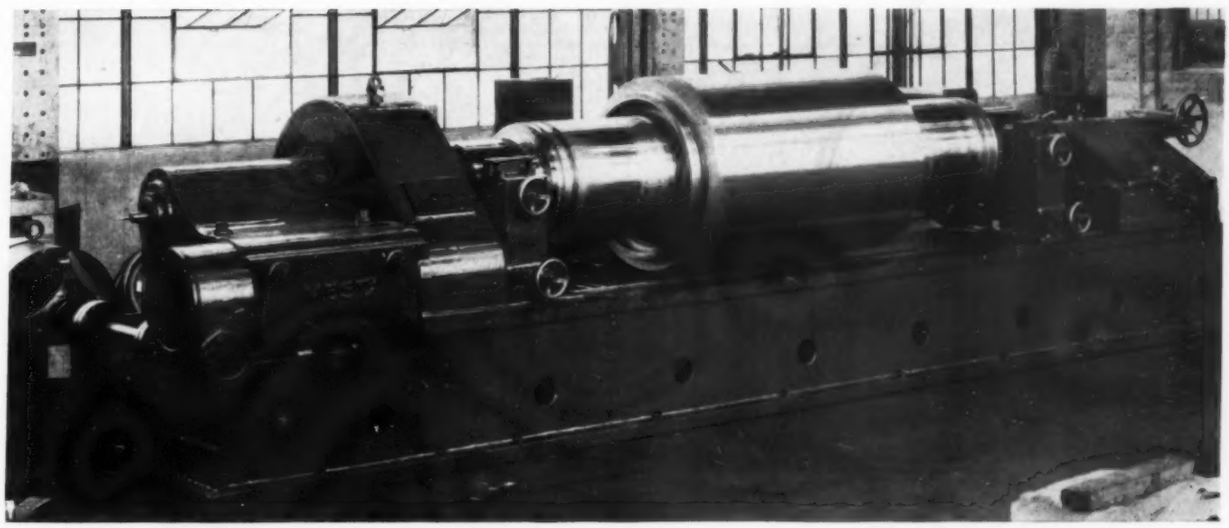
The Flexarc welder is a sturdy, compact unit designed for general welding service or production work with bare, dust coated or heavy coated electrodes. The arc is extremely stable and adjusts itself automatically to varying conditions producing strong, uniform welds equally well on thick or thin gauge metals.

The set is self contained from the conduit box to the welding terminals. The outer sheel consists of two parts bolted together forming a sturdy rigid unit. A one piece common shaft supported by two super sealed ball bearings carries the rotating parts. The new set eliminates the use of meters, exciter, rheostat, reactor, unnecessary pushbuttons, field discharge resistor, starter holding coil, and the conventional underframe.

SKF *Ball Bearings*

PRODUCE SMOOTH FINISH

On Roll Grinders



SKF-EQUIPPED BUILT BY MESTA MACHINE CO.

SKF Bearings and this Mesta Roll Grinder work together in grinding smooth roll surfaces year after year. Because of the accuracy and long life of SKF Bearings on the spindle, initial alignment is maintained over a long period of time.

Smooth SKF Bearings help eliminate chatter-marks without the necessity of bearing adjustments. SKF precision bearings always assure long wheel life, increased production, and a minimum of maintenance costs. Information concerning spindle applications in general are given in our bulletin, "Smooth Grinding With SKF Bearings."

SKF

BALL AND ROLLER BEARINGS 3494

SKF INDUSTRIES, INC., FRONT ST. & ERIE AVE., PHILA., PA.

ADVERTISING PAGES REMOVED

Association Activities

PITTSBURGH SECTION

H. G. R. Bennett, Chairman — C. H. Hunt, Secretary

Cardinal Room, William Penn Hotel

Saturday Afternoon—2:00 P. M.

December 14, 1935

"Designing for Lubrication" by C. R. Hand, Lubricating Engineer, Bethlehem Steel Company, Sparrows Point, Md.

CHICAGO SECTION

H. G. Hauge, Chairman — A. J. Whitcomb, Secretary

Annual Christmas Party at Hotel Shoreland, December 6, 1935.

PHILADELPHIA SECTION

M. J. Conway, Chairman — L. O. Morrow, Secretary

Engineers' Club—1317 Spruce Street

Dinner 6:00 P. M. — Meeting 7:00 P. M.

Saturday, December 7, 1935

"Ventilation of Rolling Mill Motors and Motor Rooms", by H. H. Angel, Elec. Dept., Bethlehem Steel Company, Sparrows Point, Md., and C. B. Huston, Ind. Engr. Dept., General Electric Co., Schenectady, N. Y.

CLEVELAND SECTION

J. H. Barse, Chairman — W. W. Spanagel, Secretary

Hotel Statler—November 21,—8:00 P. M.

"The Readjustment in Engineering Education", by Dr. W. E. Wickenden, President, Case School of Applied Science. This is a joint meeting with the Cleveland section of the A.I.E.E.

BIRMINGHAM SECTION

J. B. Looney, Chairman — B. Thele, Secretary

Date of meeting and details will be announced later.